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Targeting Education to Reduce Obesity: At What Life Stages are Interventions Effective?

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Targeting Education to Reduce Obesity: At What Life Stages are Interventions Effective?

by

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Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

May 2015

Dedication

To the memories of Murray Benson, Barbara Benson, and Heather Kizito.

Acknowledgements

Many thanks to my dissertation co-chairs, Jacqueline Angel and Paul von Hippel, for your wisdom and support. Thanks also to the rest of the committee, Catherine Cubbin, Mark Hayward, and Carolyn Heinrich, for your invaluable insight.

I'm especially grateful to my PhD comrades, for the untold hours of working alone together in coffee shops all over Austin. This process would have been harder and much less fun without you.

Targeting Education to Reduce Obesity: At What Life Stages are Interventions Effective?

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The University of Texas at Austin, 2015

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Obesity is a serious policy problem, contributing an estimated $113.9b to medical expenditures in the US. Like many health outcomes, obesity is not distributed at random in the population but is concentrated amongst the less educated. Given this, many have suggested that if more people were to become highly educated, the obesity epidemic might be curtailed. However, this assumes that the association between education and obesity is a causal one, which is not necessarily the case. Moreover, previous research in lifecourse epidemiology suggests that education may occur too late in the lifecourse to have any effect on health trajectory. I perform three empirical studies to examine whether there is a plausibly causal relationship between education and body weight, and examine whether there is a point at which it is too late to alter body weight trajectories using education. All three studies use data from the National Longitudinal Survey of Youth 1979 (NLSY79), a complex random sample of the US civilian population aged 14-22 in 1978 and followed for more than three decades. In the first study, a cross-sectional regression finds a relationship between education and BMI. I use fixed effects models with individual slopes to test whether gaining a qualification leads to a change in BMI while controlling for individual heterogeneity, and find there is no effect. In study two, I consider the effects of education completed "on-time" with education completed "late". Fixed effects models show that women who earn bachelor's degrees on time benefit from lower BMI, but there is no benefit for late degrees or other qualifications and men do not similarly benefit. The third study stratifies the analysis by early-life circumstances and finds that in a cross-sectional analysis at age 45 only the most advantaged strata benefited from having earned a bachelor's degree. In fixed effects models, gaining a degree did not lead to a change in BMI for any group. Collectively, these findings cast doubt on education's viability as a policy tool to address obesity, and suggest that at some point in the lifecourse it is too late to alter BMI trajectories by improving socio-economic status.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Obesity has received much attention as a public health problem with potentially severe economic consequences. Obesity is linked to a host of morbidities including type II diabetes, CHD, and several cancers, as well as risk factors for these and other conditions such as hypertension, insulin resistance, dyslipidaemia, in addition to premature mortality (Hubert, Feinleib, McNamara, & Castelli, 1983; Kim & Popkin, 2006; Masters, Hummer, & Powers, 2012). Treatment for the sequelae of obesity are expensive and are estimated to account for $113.9b of spending in the health system (Tsai, Williamson, & Glick, 2011). Chronic diseases and mortality arising from obesity may effect productivity. Overweight and obese individuals, particularly women, face discrimination and prejudice that manifests not only in social interactions but also impedes labour market outcomes. For example, overweight and obese women are less likely to be hired and are likely to be paid less than their normal-weight peers (Baum & Ford, 2004; Han, Norton, & Stearns, 2009). The economic costs of obesity in terms of both direct costs to the health care system and costs related to the sociology of obesity are high.

In addition, there is an equity concern to the obesity epidemic. The distribution of overweight and obesity in the population is not random, but instead is correlated with socio-economic position. Those on low incomes, in low status occupations, or with less education are more often overweight or obese than those individuals of higher SES. Beyond the ethical concerns about such an unequal distribution, concentration of the epidemic in the least advantaged segments of society means that a greater share of the health costs will be borne by the public systems. Moreover, the opportunities for low SES individuals to improve their situations, and perhaps move beyond various public assistance programmes, is limited by the by the discrimination faced in the labour market.

Some suggest that making education more accessible and thereby increasing the education level of the population may improve be effective in combatting the obesity epidemic and making it more equitably distributed. A central tenet of public health is that health is determined by “the conditions in which people are born, grow, live, work, and age” (CSDH, 2008). Those who seek to improve population health therefore focus their attention outside of what is traditionally considered the domain of health policy – the organisation and delivery of medical care – on policies that contribute to these conditions. Education is a an arena which has received considerable attention from public health scholars as a policy tool with the potential to effect the distribution of health and illness (e.g. B. J. Low & Low, 2006; M. Low, Low, Baumler, & Huynh, 2005).

Given the obesity epidemic, its concentration among less-educated individuals, and the population health community’s interest in social determinants of health, education may be of interest as a policy tool to improve obesity outcomes at the population level. As all new students of statistics learn, correlation is not causation. The fact that BMI’s distribution closely follows the distribution of education does not necessarily imply that education protects against weight gain and obesity. There are plausible mechanisms by which such a causal relationship could occur, but there are equally plausible explanations for the observed association that require no direct or indirect effect of education on body weight or weight trajectory. These are explored in detail in subsequent chapters of this dissertation, but, briefly, the two non-causal explanations for the relationship between education and BMI are 1) there is a third factor that determines both educational attainment and BMI, and 2) the causal relationship is actually reversed so that BMI determines educational attainment.

Education as a variable along which there is a gradient in BMI or any health outcome typically refers to qualifications attained or to years of education. Divisions between those who earn bachelor's degrees and high school diplomas, or those with 10 versus 16 years of education, typically mark attainment in late adolescence or adulthood. But research in lifecourse epidemiology provides reasons to think this might be too late to alter health trajectories.

There are two theories that would predict education (as a marker of SES that is achieved largely in adulthood) may occur too late for any meaningful effect on health. The first is that the relationship between socio-economic exposures and health are timing dependent and the second is that exposure to disadvantage accumulates (Ben-Shlomo & Kuh, 2002; Hallqvist, Lynch, Bartley, Lang, & Blane, 2004). Timing-based hypotheses suggest that there are developmental periods during which health trajectories are established. These are conceptualised as either "critical periods" meaning that exposures during these periods entirely determine one's health, or "sensitive periods" meaning that exposures during these periods exert much greater effects than exposures at other stages. If these critical or sensitive periods occur prior to the completion of education, then gaining education would not be expected to improve health.

The alternative theory explaining the importance of the lifecourse in health and development is based on a view of cumulative (dis)advantage. Such theories frame the relationship between SES and health outcomes (such as obesity) as a dose-response relationship. Cumulative theories, as the name suggests, posit that as the length of exposure to socio-economic disadvantage increases physiological effects accumulate, gradually causing wear and tear on the body and making it susceptible to health insults (Ferraro & Kelley-Moore, 2003; Ferraro & Shippee, 2009; Riley, 1989; Walsemann, Geronimus, & Gee, 2008). From a cumulative perspective, someone who becomes highly educated spent several years previously as a less educated person and may have been exposed to health risks during that period.

Although distinguishing between timing and cumulative processes is often not possible (Hallqvist et al., 2004), abundant empirical evidence links temporally distant socio-economic exposures and health measures. Less abundant are empirical studies considering the effects of timing of socioeconomic exposures to obesity. One British study found that men's SES at birth and women's SES at age 7 predicted BMI at age 33 when adjusted for SES at birth, 7 years, and 16 years, and these effects were robust to the inclusion of controls for parental BMI and education attained by age 33 (Power et al., 2005). Although not related to socioeconomic exposures, one study suggests there are three critical periods with regard to adult obesity: gestation and early infancy, the "adiposity rebound" typically experienced at between five and seven years of age, and adolescence (Dietz, 1994).

With this background, there are two questions motivating this dissertation: Can education be an effective tool in improving population health? Can the health consequences of earlier disadvantage be ameliorated by subsequent improvements in socio-economic circumstances? To answer these questions I conduct three studies examining different aspects of the relationship between education and BMI.

The first study attempts to isolate the causal effects of education on BMI from effects attributable to confounding or reverse causality. This is achieved by using fixed effects (FE) models and fixed effects models with individual slopes (FEIS) to ensure the correct temporal sequencing and allow individual heterogeneity in both intercept and slope to be correlated with education. This chapter establishes that there is a relationship between BMI or body weight status at age 17 and the educational level attained by the mid-40s. The FE models show a relationship between education and BMI that is much weaker than that estimated in a linear regression in the mid-40s, and the relationship fully disappears in the FEIS models. These findings suggest that the frequently observed inverse relationship between education and BMI is not attributable to education being protective against weight gain.

The second study examines whether the effects – or non effects – of education differ for those who complete their education later than the normative age. Using models similar to those in study 1, this study finds that women who complete bachelor's degrees on time do experience weight loss (or slower weight gain) than women who do not earn bachelor's degrees, while women who earn degrees late *gain* weight (or gain weight faster) than those women who do not earn bachelor's degrees.

Study three explores the possibility of heterogeneous effects of education for individuals from different socio-economic backgrounds. Using probit regression, propensity to earn a bachelor's degree is calculated and the sample is then stratified into groups with similar propensity scores and similar distributions of the propensity score generating variables. Within each of these strata I performed the same cross-sectional and longitudinal analyses as in study one. As in study one, the cross sectional association was not maintained in the FEIS models. This suggests that there is no difference in the effect of education by early background, and that education does not change the BMI trajectory established by early life circumstances.

Collectively, these studies establish that education is not a generally effective tool with which to lower obesity prevalence or make its distribution more equitable. They also suggest that timing matters and there may indeed be a point in the lifecourse beyond which one's previous exposures to socio-economic disadvantage cannot be overcome. Chapter five discusses the implications of these findings.

REFERENCES

Baum, C. L., & Ford, W. F. (2004). The wage effects of obesity: a longitudinal study. *Health Economics*, *13*(9), 885–899. http://doi.org/10.1002/hec.881

Ben-Shlomo, Y., & Kuh, D. (2002). A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *International Journal of Epidemiology*, *31*(2), 285–293. http://doi.org/10.1093/ije/31.2.285

CSDH. (2008). Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health : Final Report of the Commission on Social Determinants of Health. World Health Organization.

Dietz, W. H. (1994). Critical periods in childhood for the development of obesity. *The American Journal of Clinical Nutrition*, *59*(5), 955–959.

Ferraro, K. F., & Kelley-Moore, J. A. (2003). Cumulative Disadvantage and Health: Long-Term Consequences of Obesity? *American Sociological Review*, *68*(5), 707–729. http://doi.org/10.2307/1519759

Ferraro, K. F., & Shippee, T. P. (2009). Aging and Cumulative Inequality: How Does Inequality Get Under the Skin? *The Gerontologist*, *49*(3), 333–343. http://doi.org/10.1093/geront/gnp034

Hallqvist, J., Lynch, J., Bartley, M., Lang, T., & Blane, D. (2004). Can we disentangle life course processes of accumulation, critical period and social mobility? An analysis of disadvantaged socio-economic positions and myocardial infarction in the Stockholm Heart Epidemiology Program. *Social Science & Medicine*, *58*(8), 1555–1562. http://doi.org/10.1016/S0277-9536(03)00344-7

Han, E., Norton, E. C., & Stearns, S. C. (2009). Weight and wages: fat versus lean paychecks. *Health Economics*, *18*(5), 535–548. http://doi.org/10.1002/hec.1386

Hubert, H. B., Feinleib, M., McNamara, P. M., & Castelli, W. P. (1983). Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation*, *67*(5), 968–977. http://doi.org/10.1161/01.CIR.67.5.968

Kim, S., & Popkin, B. M. (2006). Commentary: Understanding the epidemiology of overweight and obesity—a real global public health concern. *International Journal of Epidemiology*, *35*(1), 60–67. http://doi.org/10.1093/ije/dyi255

Low, B. J., & Low, M. D. (2006). Education and Education Policy as Social Determinants of Health. *Virtual Mentor*, *8*(11), 756–761. http://doi.org/10.1001/virtualmentor.2006.8.11.pfor1-0611

Low, M., Low, B., Baumler, E., & Huynh, P. (2005). Can education policy be health policy? Implications of research on the social determinants of health. *Journal of Health Politics, Policy & Law*, *30*(6), 1131–1162.

Masters, R. K., Hummer, R. A., & Powers, D. A. (2012). Educational Differences in U.S. Adult Mortality A Cohort Perspective. *American Sociological Review*, *77*(4), 548–572. http://doi.org/10.1177/0003122412451019

Power, C., Graham, H., Due, P., Hallqvist, J., Joung, I., Kuh, D., & Lynch, J. (2005). The contribution of childhood and adult socioeconomic position to adult obesity and smoking behaviour: an international comparison. *International Journal of Epidemiology*, *34*(2), 335–344. http://doi.org/10.1093/ije/dyh394

Riley, J. C. (1989). Sickness, Recovery, and Death: A History and Forecast of Ill Health. University of Iowa Press.

Tsai, A. G., Williamson, D. F., & Glick, H. A. (2011). Direct medical cost of overweight and obesity in the USA: a quantitative systematic review. *Obesity Reviews*, *12*(1), 50–61. http://doi.org/10.1111/j.1467-789X.2009.00708.x

Walsemann, K. M., Geronimus, A. T., & Gee, G. C. (2008). Accumulating Disadvantage Over the Life Course Evidence From a Longitudinal Study Investigating the Relationship Between Educational Advantage in Youth and Health in Middle Age. *Research on Aging*, *30*(2), 169–199. http://doi.org/10.1177/0164027507311149

Chapter 2: Data and Sample Characteristics

All three studies in this dissertation use data from the National Longitudinal Survey of Youth (1979). The sample was a complex random sample of the non-institutionalised U.S. population who were aged 14-22 in 1978. Blacks, Hispanics, and youth from economically disadvantaged homes were oversampled. Respondents were interviewed annually between 1979 and 1994, and every two years thereafter. Analyses in this dissertation utilise data collected between 1979 and 2010.

Characteristics of the sample at baseline are shown in Table 1. Weighted values in the table account for unequal probabilities of selection so that generalisations can be drawn about the wider population. At baseline, the sample was evenly divided by gender. Approximately 80% of the initial sample was non-black and non-Hispanic. At the earliest weight measurement, when participants' ages ranged from 17 to 224, the majority (74%) were normal weight.

Many of the analyses undertaken were longitudinal. Table 2 shows sample attrition by wave. At the most recent wave, 76% of participants remained. The NLSY79 data makes available weights that account for both unequal selection probability and the attrition – and potential rejoining – of sample members. However, all analyses in this dissertation are unweighted, for two reasons. Firstly, the longitudinal models employed listwise deletion for observations with missing data. Secondly, the longitudinal models in this dissertation are indexed by age while the available longitudinal weights are based on years. Each of these factors would distort the weights, making weighted analysis of the sample no more representative of the wider population than unweighted analysis.

Throughout this dissertation the dependent variable is body mass index (BMI), calculated as weight in kilograms divided by the square of height in metres. In survey years 1981, 1982, 1985, 1986, 1988, 1989, 1990, 1992, and from 1993 onwards participants self-reported their weight. Height was self-reported in 1981, 1982, 1985, 2006, 2008, and 2010. Height in 1981 and 1982 was used to calculate BMI in those years, and height in 1985 was used thereafter. In models where BMI is measured on participants aged less than 18, categorical weight status assignment was based on the 85th and 95th percentiles of the CDC's growth charts.

The independent variable is education. Binary variables indicated whether respondents had high school diplomas, associate's degrees, bachelor's degrees, and graduate or professional degrees. These are not mutually exclusive; for example, a bachelor's degree holder continues to be coded as having a high school diploma unless noted otherwise. Values were assigned on the basis of variables indicating whether the respondent was a high school graduate/GED holder or not in all years, the highest qualification held at the beginning of the study, and reports of attaining a new qualification in any wave. Where gaps exist in the educational record, 2008 and 2010 reports of highest qualification and the year attained were used when these were consistent with data before and after the missing year.

Table 2.1: Sample characteristics at baseline (N=12,686)

	n	weighted %
RACE/ETHNICITY		
Hispanic	2,002	6.3
Black	3,174	13.9
Non-black, non-Hispanic	7,510	79.8
SEX		
Male	6,403	50.8
Female	6,283	49.2
WEIGHT STATUS (1981)		
Underweight	702	6.2
Normal weight	8,905	73.8
Overweight	1,971	15.8
Obese	535	4.1
	Weighted Mean	Weighted SE
Age	17.7	0.03
Mother's education (years)	11.6	0.03
Number of siblings	3.4	0.02

Females (6,283)

	n	weighted %
RACE/ETHNICITY		
Hispanic	1,002	6.3
Black	1,561	14.0
Non-black, non-Hispanic	3,720	79.7
WEIGHT STATUS (1981)		
Underweight	542	10.1
Normal weight	4,477	75.2
Overweight	727	10.7
Obese	268	3.9
	Weighted Mean	Weighted SE
Age	17.8	0.03
Mother's education (years)	11.5	0.04
Number of siblings	3.4	0.03

Males (6,403)

	n	weighted %
RACE/ETHNICITY		
Hispanic	1,000	6.2
Black	1,613	13.7
Non-black, non-Hispanic	3,790	80
WEIGHT STATUS (1981)		
Underweight	160	2.4
Normal weight	4,428	72.4
Overweight	1,244	20.8

Table 2.1 cont.		
Obese	467	4.3
	Weighted Mean	Weighted SE
Age	17.8	0.03
Mother's education (years)	11.7	0.04
Number of siblings	3.3	0.03

Table 2.2: Sample Attrition[1]

Participated	n	% remaining
1979	12,686	
1980	12,141	95.7%
1981	12,195	96.1%
1982	12,123	95.6%
1983	12,221	96.3%
1984	12,069	95.1%
1985	10,894	93.9%
1986	10,655	91.8%
1987	10,485	90.3%
1988	10,465	90.2%
1989	10,605	91.4%
1990	10,436	89.9%
1991	9,018	90.5%
1992	9,016	90.5%
1993	9,011	90.4%
1994	8,891	89.2%
1996	8,636	86.7%
1998	8,399	84.3%
2000	8,033	80.6%
2002	7,724	77.5%
2004	7,661	76.9%
2006	7,654	76.8%
2008	7,757	77.8%
2010	7,565	75.9%

[1] Source: NLSY79 Retention and reasons for non-interview. Available at https://www.nlsinfo.org/content/cohorts/nlsy79/intro-to-the-sample/retention-reasons-noninterview

Chapter 3: Does Education Prevent Weight Gain?

INTRODUCTION

In high-income countries like the United States, educational attainment is inversely correlated with body size. Those with low levels of education tend to have higher body mass index (BMI) and are more likely to be obese than more educated individuals. For those hoping to intervene in the obesity epidemic and its concentration in the least advantaged groups in society, it is important to understand how this correlation arises. If education is protective against obesity or high BMI then a potential policy target may be increasing educational attainment. On the other hand, if the correlation between BMI and obesity exists because individuals of different body sizes have different likelihoods of pursuing education, then policy intended to increase access to or participation in education would not affect obesity or BMI outcomes in the population.

The most straightforward theory by which education is postulated to affect health outcomes such as body size is that education enhances human capital which in turn enhances health. The mechanism is as follows. The process of becoming educated – whether through the knowledge imparted as part of curricula, practice at skills related to generating knowledge and solving problems, or the experience of being in educational environments – may change individuals in ways that are conducive to health. Education may make individuals more knowledgeable about their health, increase their ability to critically evaluate information that relates to their health, and make them more likely to believe that their health is within their control. These benefits of education are collectively referred to by Mirowsky and Ross (2003) as "learned effectiveness".

Alternatively, education may result in health benefits not through its transformative effect on individuals but by providing a signal that sorts individuals within social and economic hierarchies. Because the information costs of ascertaining whether a potential new social acquaintance or employee (for example) has a desired set of traits or skills are high, education can be used as a proxy for these desirable characteristics. The benefits of qualifications over and above the benefits of education itself have been dubbed the "sheepskin effect". For health it is not clear whether the human capital or sheepskin effect mechanism is more important. Studies comparing outcomes for people who completed the same number of years of education with and without earning a degree show that the degree itself, not just the years of schooling, predicts health outcomes (for example, Liu et al., 2011, 2013). In contrast, a study comparing multiple ways of modelling the relationship between education and mortality found that the model with the best predictive power included both years of education and qualifications attained, suggesting that both human capital and the sheepskin effect played a role (Montez, Hummer, & Hayward, 2012). The distinct effect of qualification over instead of or in addition to years of schooling has two competing explanations. The first is that the act of earning a qualification requires more than being in school for a given length of time, and so people who have the skills necessary to convert years of education into a qualification may have some abilities lacking in those with comparable years of education but no degree. Alternatively, credentialism may be occurring as the costs to assign meaning to a given qualification are lower than the costs of evaluating education on a case-by-case basis.

The above mechanisms all assume that education is causally related to body weight, perhaps lowering BMI in larger individuals, or perhaps slowing or halting the growth in BMI that occurs across the life course. However, there is a body of work that implies the established relationship between obesity and BMI may be due not to the effects of education but instead to differential educational attainment by body size. In a study of young people in the US born between 1980 and 1984, von Hippel and Lynch (2014) found that young women who were overweight or obese were less likely than their normal weight peers to be highly educated, and this accounted for the majority of the education-obesity relationship observed at age 29. A Swedish study of over 700,000 men born between 1952 and 1973 found that men who were obese at age 18 were less likely to attain high education than their normal weight peers (Karnehed, Rasmussen, Hemmingsson, & Tynelius, 2006). One study used the same data as that used here to compare the educational attainment of overweight and non-overweight young adults aged 16-24, (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993). Overweight women went on to complete 1.1 fewer years of schooling than non-overweight women when no other variables were controlled; this effect dropped to 0.3 years after adjustment for a range of socioeconomic variables. However, the same study found no difference in educational attainment between overweight and non-overweight men when socioeconomic control variables were included, and found no significant difference between overweight and non-overweight subjects in the probability of earning a college degree for either sex.

These findings of weight status preceding educational attainment raise the possibility that rather than education protecting against high body weight, high body weight causes earlier cessation of education. A possible causal pathway lies in the norms around body size, particularly for women. Teenagers who are overweight or obese are more likely than their normal-weight peers to experience depression, have poorer relationships with friends, and have lower educational expectations (Falkner et al., 2001), although it is not always clear whether these preceded or followed becoming overweight or obese. They are also likely to experience stigma and low educational expectations from their teachers (Neumark-Sztainer, Story, & Harris, 1999). In one study, perceived cognitive ability in children as young as five was found to be associated with on body weight status (Davison & Birch, 2001). Combined, these factors may inhibit the educational attainment of obese and overweight young people.

An alternative explanation to a causal relationship – in either direction – between body weight and education is that the two share a common cause. Several potential common causes have been explored in the literature, either in regard to obesity specifically or health more generally. Perhaps the most straightforward is the role of physical activity. Physical activity increases energy expenditure, reducing the number of excess calories consumed and thus preventing the accumulation of body fat. Physical activity has also been linked to increased cognitive function (Castelli, Hillman, Buck, & Erwin, 2007; Hillman et al., 2006; Kramer & Erickson, 2007), which may lead to greater educational attainment. Thus those who are physically active may be more likely both to have a healthy body weight and to advance in education, confounding the relationship between education and body size. Conversely, physical or mental health problems or their treatments may lead to both weight gain and impaired academic performance.

A frequently advanced explanation for the apparent relationship between health outcomes, especially obesity, and education is the existence of personality traits that promote healthy body weight and educational attainment. Examples of such traits include the ability to delay gratification (Bruce et al., 2011; Weller, Cook III, Avsar, & Cox, 2008) and conscientiousness (Jokela et al., 2013; Provencher et al., 2008), while traits found to be more common in those with lower levels of educational attainment and higher odds of obesity or other indicators of poor health include a tendency to discount the future (Becker & Mulligan, 1997; Wardle & Steptoe, 2003). Another factor that may contribute to both educational attainment and obesity is parental or childhood socio-economic status, measured with such markers as income, maternal education, paternal occupation, and others. Both educational attainment and obesity are strongly correlated with parental SES, and so both may simply be markers of early life (dis)advantage) (Galobardes, Shaw, Lawlor, Lynch, & Smith, 2006). Finally, it should be noted that the three confounders described above – physical activity, personality traits, and parental SES – are not mutually exclusive. They may each have independent effects on education and BMI, as well as potentially mediating or moderating each other.

In this study, I attempt to establish whether the relationship between education and obesity can be plausibly attributed to education affecting body weight in light of evidence that body weight status may precede educational attainment. There are a plethora of studies reporting a relationship between education and obesity or body weight, framed either as the effect of education on obesity, or the effect of body size shaping educational attainment. Rarely, however, are both directions considered simultaneously. I attempt to fill this gap by using teenage body weight to predict middle-age education while also testing whether increases in education predict lower body weight.

METHODS

Data

The sample and measurement of the dependent and independent variables are described in chapter 2.

MEASURES

In addition to continuous BMI measure described in chapter 2, in this study I also use a binary dependent variable. BMIs 25 or above are overweight or obese and are coded 1; BMIs less than 25 are non-overweight and coded 0.

Control variables To reduce the possibility of observing a spurious association between education and BMI due to confounding, several control variables were included. In predicting educational attainment at age 45 with BMI at age 17 these controls were maternal education measured in years of completed schooling, number of siblings in 1979, percentile score on a standardised aptitude test administered during the first wave of the study, binary indicators of whether the participant was Hispanic, black, or non-black non-Hispanic, and, for women, whether they had ever been pregnant by age 17. For models predicting change in BMI with change in educational attainment control variables were linear and polynomial functions of age in years, income, marital status, and employment status.

Analytic Strategy

In order to identify the potentially causal effect of education on obesity it is necessary to first determine if a selection effect may account for the observed relationship. It may be the case that obesity determines educational attainment rather than or in addition to the reverse. I examined this possibility by using BMI at age 17 to predict educational attainment at age 45 using an ordinal logistic model. The ordinal model produces estimates for the log odds of being at a given level of education or higher to those of being in a lower level, for each possible transition:

$$\ln\left(\frac{p_{higher}}{p_{lower}}\right)=\alpha+\beta weightstatus+\beta controls \qquad (1)$$

Each level of education creates a binary division between having attained *at least* that level and not having attained that level. The coefficients represent the log odds of having attained the higher level, which are usually exponentiated to produce odds ratios for greater interpretability. For binary education outcomes (any post-secondary education; bachelor's degree or higher) I used a binary logistic regression.

I created a series of models to explore the plausibility of a causal relationship between education and BMI/obesity. The first of these were cross-sectional analyses at age 45, which is the age of the youngest panel members in the most recent wave of data. The ordinary linear regression (OLS) model for the ordinal education outcome is:

$$BMI=\beta_0+\beta_1 HSgrad+\beta_2 sub\text{-}baccalaureate+\beta_3 bachelor's+\beta_4 professional/graduate+\varepsilon \quad (2)$$

Model (2) established the magnitude of the association between education and BMI. However, there are many reasons this model is unlikely to represent a causal relationship, namely confounding and selection/reverse causality. I therefore changed these models incrementally to address various threats to causal inference. The first change to model (2) was simply to add variables that may confound or mediate the relationship of interest, resulting in model (3):

$$BMI=\beta_0+\beta_1 HSgrad+\beta_2 sub\text{-}baccalaureate+\beta_3 bachelor's+\beta_4 professional/graduate+\beta_5 income+\beta_6 maritalstatus+\beta_7 employmentstatus+\varepsilon \quad (3)$$

Cross-sectional modelling cannot ensure that education occurred before the individual attained their observed body weight. Fixed effects models take advantage of the longitudinal nature of the data and predict the effects of a *change* in educational status on change in BMI/obesity. The fixed effects model is:

$BMI_{it}= \beta_0+\beta_1 HSgrad_{it}+\beta_2 sub\text{-}baccalaureate_{it}+ \beta_3 bachelor's_{it}+\beta_4 professional/graduate_{it} + \beta_5 age_t+\beta_6 age\text{-}squared_t+ u_i +\varepsilon_{it}$

(4)

BMI typically increases with age and so it is necessary to incorporate age into the model. I used a linear and quadratic age term (see chapter 4 and particularly table 4.1 for rationale for this functional form). The binary outcome model is similar, with the independent variables predicting the log odd of being overweight or obese for those with the given characteristic (or for a one unit increase in continuous measures) relative to those without.

$\ln(\frac{p_{q overweight/obese}}{p_{not\ overweight/obese}})= \beta_0+\beta_1 high\ school_{it}+\beta_2 associates\ degree_{it}+ \beta_3 bachelor's\ degree_{it} +\beta_4 graduate\ or\ professional\ degree_{it} + u_i$

(6)

In the above models the BMI for individual *i* at age *t* are functions of the individual's education status and age. Specifying that the dependent and independent variables are for individual *i* at age *t* is an advantage over the cross sectional models above because education that occurs after BMI measurement does not influence coefficient estimates. The risk of reverse causality is thus greatly reduced, although not eliminated as body weight between measurement occasions is unknown.

The inclusion of the u_i term offers the second advantage of fixed effects models compared to the OLS. This term represents individual characteristics that do not vary over time, for example parental SES or personality traits such as conscientiousness. While the cross-sectional models can deal with potential confounding only by including control variables, the fixed effects models are unaffected by confounders that are time invariant. Given that potential confounders of the relationship between education and body weight include personality traits and other difficult to measure constructs, this is an important advantage.

While the fixed effects model offers important advantages over cross-sectional models, it does rely on assumptions that may not be tenable. One of these is the parallel trends or strict exogeneity assumption, which demands that absent treatment, trends in the dependent variable would be parallel for all groups. In other words, slopes will be equivalent between groups, which is not necessarily a valid assumption. Adding individual slopes to the model relaxed this assumption (Brüder & Ludwig, 2014):

$$BMI_{it}= \beta_0+\beta_1 HSgrad_{it}+\beta_2 sub\text{-}baccalaureate_{it}+ \beta_3 bachelor's_{it}+\beta_4 professional/graduate_{it} + \beta_5 age_t+\beta_6 age\text{-}squared_t+age_{it}(\beta_7 HSgrad_{it} +\beta_8 sub\text{-}baccalaureate_{it} + \beta_9 bachelor's_{it}* +\beta_{10} professional/graduate_{it})+ age\ squared_{it}(\beta_{11} HSgrad_{it} +\beta_{12} sub\text{-}baccalaureate_{it} + \beta_{13} bachelor's_{it}* +\beta_{14} professional/graduate_{it})+ u_i +\varepsilon_{it} \quad (7)$$

Models (6) and (7) utilised clustered standard errors to account for the non-independence of observations for individuals over time. Both were run with and without controlling for marital status, employment status, household income, and having children (for women).

Missing data

Education had a large amount of missing data. For several years (1985-1988) respondents were not asked about their educational qualifications. As the panel progressed, education data were missing as individuals declined to provide the information, were not interviewed in a particular year, or were permanently lost to follow-up. In some cases it was possible to fill in missing values based on other values; for example, if a respondent had the same level of education in the waves prior to and following missing values, they were reported as having that same level of education in the missing wave.

Many of the panel did not have body weight recorded at age 17. The first wave in which body weight was collected was 1981, and with birth years for this panel ranging from 1957 to 1964, many were already older than 17 years of age. Rather than limit the selection model to the youngest members of the sample and lose the majority of the available data as well as statistical power, I elected to use multiple imputation. Later BMI, as well as education, marital status, and employment status were used to predict BMI at age 17 with the data in wide format throughout the imputation process.

In brief, multiple imputation involves generating plausible values for missing data based on non-missing data for both the variable(s) with missing data and those without. There are several methods of generating the imputed data; I used a chained approach. In this approach, the missing values are generated based on regressing the variable with missing values against other variables, then generating values for the missing data that result in the same regression coefficients, and finally adding random error to the imputed values. A number of imputed data sets are created, with each imputed data set differs in the random error assigned to each missing value. Statistical analysis is performed on each imputed data set and the original and the estimates are combined based on formulae provided by Rubin (1987). All imputation and analyses were performed using the MI suite of commands in Stata 13.1. Imputation was only used for models (1)-(3); computational limitations prevented imputation for longitudinal analyses.

RESULTS

Table 3.1 shows the results of an ordinal logistic regression predicting education at age 45. For men, weight category at age 17 has no relationship to educational attainment at age 45. For women, being overweight is associated with a 27% reduction in the odds of attaining a higher level of education by age 45, while being overweight is associated with a 50% reduction in odds. These estimates have wide confidence intervals; the true reduction in the odds of achieving a higher level of education may be as small as 8% or as large as 42% for overweight women and 17% to 30% for obese women. Using standardised BMI as the independent variable in place of the ordinal weight categorisation resulted in no association between BMI and education for men, while for women a 1sd increase in BMI was associated with a 12% (OR 0.88, 95% C.I. 0.80, 0.97) reduction in the odds of attaining a higher level of education (not shown).

According to table 3.1, each additional year of maternal education is associated with a 13% increase in the odds of a higher level of educational attainment for men and an 11% increase for women. Each percentile increase in score on the AFQT aptitude test is associated with a 4-5% increase in odds of reaching a higher level of education by age 45, while each additional sibling delivers a 5% reduction in these odds. For women, having been pregnant by age 17 dramatically reduces the odds of increased educational attainment. Being black or Hispanic is associated with an increase in the odds of reaching an increased level of education when these other factors are controlled.

The ordinal logistic model assumes that the relationship between BMI status and education is the same for each category of education, so that each independent variable has a single coefficient or odds ratio. In other words, being obese is assumed to have the same effect on the odds of transitioning from less than high school to high school as on transitioning from a bachelor's degree to a graduate or professional degree. Given that BMI was measured at age 17, around the time teenagers become high school graduates but several years removed from the time adults become college graduates or graduate/professional degree holders, this assumption may not be reasonable. Because of this I also employed a multinomial logistic model, however, for most comparisons the model provided quite imprecise estimates. The results are shown in appendix 3.1. The selection effect demonstrated in the ordinal model should be considered to be an average, with effect sizes likely to differ depending on which educational transition one is considering.

Figure 3.1 plots mean BMI by age for each level of education attained at age 45. Note that education in this figure represents the highest qualification attained and so the categories are mutually exclusive. For men, mean BMI was largely the same across educational groups until the mid-twenties. Two BMI trajectories were present from the mid-twenties to mid-thirties with the average BMI of those who would earn baccalaureates or graduate degrees lower than those who would not. In the mid-thirties, separation occurred between those who did not earn a high school diploma or GED and those who earned high school diplomas or associate's degrees. Similarly, separation occurred in the BMI trajectories of those who would earn a bachelor's degree and those who would earn a graduate or professional degree.

Women who would go on to attain different levels of education had different BMI trajectories from the earliest measurement, a finding consistent with the logistic models showing selection by body weight status and BMI into higher levels of education. Throughout the study period the BMI trajectories of women who would not earn a high school qualification or equivalent, only high school completion or equivalent, bachelor's degrees, and graduate or professional degrees were distinct. Those who would earn an associate's degree initially had a BMI trajectory similar to those earning bachelor's degrees, but by the late thirties were indistinguishable from those with only the high school diploma or GED.

Before age 20, there was no difference in BMI by education status for men, whereas for women there was approximately 2.5 kg/m^2 difference in the means of the highest and lowest education group. The gap for men would increase to about 2 kg/m^2 by age 45, and for women at age 45 the gap had reached about 4 kg/m^2. These findings are consistent with the ordinal logistic model which showed a selection effect into higher educational attainment for women but not for men. For men, the mean BMI rises above 25 (the transition between normal-weight and overweight) in the late 20s regardless of education level with a gap of only two or three years between this happening for the lowest and highest educated groups. In contrast, there is approximately a ten year gap between when a mean BMI of 25 is reached by the lowest and highest educated women.

Figure 3.2 shows the distribution of highest level of education attained by age. At age 25, a quarter of the sample did not have a high school diploma or GED; by age 45 about only 15% were without high school diplomas or GEDs. At age 25 approximately 20% of the sample had any post-baccalaureate qualification. This had increased to about 30% by age 45.

Tables 3,2 and 3.3 show the relationship between education and BMI at age 44 or 45. In these tables, the effect of each level of education (high school diploma or GED, associate's degree, bachelor's degree, and graduate/professional degree) is shown relative to the omitted category, no high school diploma. The first model in each table includes no control variables, the second includes income, education, marital status, income, race/ethnicity, and parental education. The final model used the same controls as well as a series of indicator variables for occupation category. In the unadjusted models, those with bachelor's degrees and graduate or professional degrees had lower predicted BMI than those with no qualifications at age 44 or 45, as did women with high school diplomas. When covariates were included in the model, only those with graduate or professional degrees were predicted to have BMI different from those with no qualifications.

Tables 3.4 and 3.5 show fixed effects models. For both men and women, regular fixed effects models suggest a small reduction in BMI after earning bachelor's and graduate or professional degrees. This does not hold when individual slopes are added to the fixed effects models. Under the FEIS model with no covariates, women who earn high school diplomas lose on average 0.21 kg/m^2 but this effect disappears when time-varying controls are included in the model.

Appendices 3.2 and 3.3 include interactions between age and education to identify differences in BMI growth by education. For women, the regular fixed effects model suggests that earning a bachelor's degree precedes a one-time increase in BMI but a slowing in BMI growth, while the FEIS model predicts the opposite – a one-time BMI decrease and an increase in BMI growth. Regular FE models predicted a slowing of BMI growth in men after earning a bachelor's degree but FEIS models did not detect a change in BMI trajectory after earning any degree.

Appendices 3.4-3.7 show the results of FE and FEIS models with a binary dependent variable for overweight and obesity. The FE models report odds ratios, and the findings are counterintuitive: gaining qualifications in many cases precedes an *increase* in the odds of being overweight or obese. The FEIS analyses are linear probability models, with the reported coefficients representing the increase in the mean value (i.e., probability) of being overweight or obese. Education did not have any effect in these models.

DISCUSSION

This study confirms that body size at age 17 predicts educational attainment at age 45. Importantly, this result was observed only in women, not men, and any credible explanation must account for this gender difference. For example, it does not seem likely that overweight or obesity are markers of general poor health that is in turn lowering cognitive ability because this process would be expected to affect young men as well as young women. If this result is observed simply because both BMI and educational attainment are markers of parental SES, then parental SES would need to act differently on the body weight of young men and young women. Few studies have considered the effect of parental SES on health or obesity separately for boys and girls, and those that have are ambiguous. For example, Huurre, Aro, and Rahkonen (2003) found that at age 16 girls' but not boys' mean BMI differed by parental SES, but neither sex differed by parental SES in the proportion overweight. There is insufficient evidence in the literature to support the assumption of differential effects of parental SES necessary to explain the present results with confounding by parental SES. Moreover, the analyses presented controlled for maternal education.

Personality traits are commonly used to explain the inverse association between socio-economic status and health outcomes like obesity. Conscientiousness and the ability to delay gratification are two of the most frequently discussed, especially with regard to obesity. Those who are conscientious or able to delay gratification may be more likely to exercise regularly and limit their consumption of energy dense foods and thus maintain a low body weight, as well as diligently completing all manner of mundane tasks necessary for academic success. Again, however, while personality traits may plausibly link BMI at age 17 to educational attainment at age 45, they fail to explain why the selection effect is present only for young women. It is possible that the social environment does not reward (or punish) maintenance of a lower (higher) body weight for men (women), resulting in men and women expressing their conscientiousness in different behaviours. This would be an example of an indirect effect of gender norms affecting body weight.

There are also plausible direct effects of gendered social norms on the selection of overweight and obese young women into lower levels of education. In the US, there is widespread evidence of discrimination and negative attitudes towards people who are overweight or obese, and, importantly, overweight and obese women experience greater levels of discrimination than do overweight and obese men (Falkner et al., 1999). People who are overweight or obese, particularly women, are viewed as lazy, lacking in self-discipline, and unintelligent (Puhl & Latner, 2007). For women, this discrimination is not only a psycho-social issue but an economic one, as women of size are paid less than normal weight women and overweight or obese men (Mitra, 2001). Obese and overweight teenaged girls similarly face discrimination, both from their peers and from adults (Puhl & Latner, 2007).

This prejudice against larger women could affect the educational attainment of overweight and obese teenage girls in two ways. Firstly, prejudices may directly impede young women's progress in education. If overweight and obese girls are viewed as lazy or unintelligent, then their mentors may discourage – or less actively encourage – them to pursue education. The second mechanism is indirect. Overweight and obese girls and young women may internalise negative stereotypes about body size (Crosnoe, 2007) and begin to see themselves as lazy or unintelligent and thus incapable of furthering their education. Experiences of discrimination and prejudice could also lead to depression or anxiety which may in turn inhibit their educational attainment.

These results differ from those of previous studies. Gortmaker et al (1993), using the NLSY79 data, found a 12 percentage point difference (9% vs 21%) in the proportion of overweight and non-overweight women who attained a bachelor's degree seven years after initial BMI measurement but this difference was not statistically different from 0 after adjusting for a similar set of covariates as the present study. This may be because Gortmaker and colleagues used the entire sample's first weight measurement, regardless of age, and had a much shorter follow up than the present study. Fowler-Brown et al (2010) found that adjustment for likely confounders resulted in a RR statistically indistinguishable from 1 of attaining a college degree by 2005 for young women who were overweight or obese in 1981 compared to women who were normal weight at the same age.

The second major finding of this study is that the educational gradient in BMI observed at age 45 is much reduced when analysed with fixed effects and completely disappears when the fixed effects models include individual slopes. In some ways this is consistent with the findings of the selection model: if high-BMI precedes educational attainment, then fixed effects models should not detect an effect of educational attainment.

This study has several strengths, most notably the use of fixed effects models with individual slopes that greatly reduce bias resulting from time-varying individual heterogeneity. However, there are also some limitations. For all models, BMI measures are based on self-reported weight and height. It is plausible that some respondents overestimated their height and/or underestimated their weight, resulting in biased measures of BMI. Moreover, this bias may differ by age and weight (Kovalchik, 2009). However, it is not clear whether this bias would differ by educational attainment.

Another limitation is the use of BMI as a dependent variable. The healthy range of BMI occurs in the middle of its distribution, and each of the categories of body weight status (underweight, normal weight, overweight, and obese) covers several BMI points. The implicit interpretation of studies using BMI in studies of population obesity is that an increase in BMI is a poor health outcome. This is not always the case; an individual whose BMI increases from 18 to 19 is likely to have improved his or her health, and an individual whose BMI increased from 22 to 23 is unlikely to have become less healthy as a result.

Conclusions and further research

This study suggests that the education gradient in BMI observed in middle age is the result of expansion of gradients that were in place from adolescence or earlier. For policy makers and researchers, this points to several directions for further work.

Policy makers must urgently address the selection of overweight and obese young women out of education. One priority should be reducing the prejudice and discrimination experienced by overweight and obese individuals, particularly women. Possible avenues include disability legislation such as the ADA, or inclusion of obesity as a protected class in a manner similar to race/ethnicity and religion. Some commentators point out that the emergence of obesity as a health issue – as opposed to an aesthetic one – may have legitimised the stigmatisation of obesity (Campos, Saguy, Ernsberger, Oliver, & Gaesser, 2006; Orbach, 2006). Efforts to improve population health by addressing the obesity epidemic should expand their narrow obesity reduction focus to include efforts at promoting the mental and social health of overweight and obese people, especially young women, by attempting to reverse the stigma associated with high body weight.

These results do not suggest that encouraging increased education at the high school diploma level or beyond would be an effective tool in addressing the obesity epidemic. Given that a gradient is already in place by age 17 for women, policy attention would be better focused earlier in the life course.

REFERENCES

Becker, G. S., & Mulligan, C. B. (1997). The Endogenous Determination of Time Preference. *The Quarterly Journal of Economics*, *112*(3), 729–758. http://doi.org/10.1162/003355397555334

Bruce, A. S., Black, W. R., Bruce, J. M., Daldalian, M., Martin, L. E., & Davis, A. M. (2011). Ability to Delay Gratification and BMI in Preadolescence. *Obesity*, *19*(5), 1101–1102. http://doi.org/10.1038/oby.2010.297

Brüder, J., & Ludwig, V. (2014). Fixed effects panel regression. In H. Best & C. Wolf (Eds.), *The SAGE Handbook of Regression Analysis and Causal Inference* (pp. 331–361). London: SAGE Publications Ltd.

Campos, P., Saguy, A., Ernsberger, P., Oliver, E., & Gaesser, G. (2006). The epidemiology of overweight and obesity: public health crisis or moral panic? *International Journal of Epidemiology*, *35*(1), 55–60. http://doi.org/10.1093/ije/dyi254

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical Fitness and Academic Achievement in Third- and Fifth-Grade Students. *Journal of Sport and Exercise Psychology*, *29*(2), 239–252.

Crosnoe, R. (2007). Gender, Obesity, and Education. *Sociology of Education*, *80*(3), 241–260. http://doi.org/10.1177/003804070708000303

Davison, K. K., & Birch, L. L. (2001). Weight Status, Parent Reaction, and Self-Concept in Five-Year-Old Girls. *Pediatrics*, *107*(1), 46–53. http://doi.org/10.1542/peds.107.1.46

Falkner, N. H., French, S. A., Jeffery, R. W., Neumark-Sztainer, D., Sherwood, N. E., & Morton, N. (1999). Mistreatment Due to Weight: Prevalence and Sources of Perceived Mistreatment in Women and Men. *Obesity Research*, *7*(6), 572–576. http://doi.org/10.1002/j.1550-8528.1999.tb00716.x

Falkner, N. H., Neumark-Sztainer, D., Story, M., Jeffery, R. W., Beuhring, T., & Resnick, M. D. (2001). Social, Educational, and Psychological Correlates of Weight Status in Adolescents. *Obesity Research*, *9*(1), 32–42. http://doi.org/10.1038/oby.2001.5

Fowler-Brown, A. G., Ngo, L. H., Phillips, R. S., & Wee, C. C. (2010). Adolescent Obesity and Future College Degree Attainment. *Obesity*, *18*(6), 1235–1241. http://doi.org/10.1038/oby.2009.463

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W., & Smith, G. D. (2006). Indicators of socioeconomic position (part 1). *Journal of Epidemiology and Community Health*, *60*(1), 7–12. http://doi.org/10.1136/jech.2004.023531

Gortmaker, S. L., Must, A., Perrin, J. M., Sobol, A. M., & Dietz, W. H. (1993). Social and Economic Consequences of Overweight in Adolescence and Young Adulthood. *New England Journal of Medicine*, *329*(14), 1008–1012. http://doi.org/10.1056/NEJM199309303291406

Hillman, C. H., Motl, R. W., Pontifex, M. B., Posthuma, D., Stubbe, J. H., Boomsma, D. I., & de Geus, E. J. C. (2006). Physical activity and cognitive function in a cross-section of younger and older community-dwelling individuals. *Health Psychology*, *25*(6), 678–687. http://doi.org/10.1037/0278-6133.25.6.678

Huurre, T., Aro, H., & Rahkonen, O. (2003). Well-being and health behaviour by parental socioeconomic status. *Social Psychiatry and Psychiatric Epidemiology*, *38*(5), 249–255. http://doi.org/10.1007/s00127-003-0630-7

Jokela, M., Hintsanen, M., Hakulinen, C., Batty, G. D., Nabi, H., Singh-Manoux, A., & Kivimäki, M. (2013). Association of personality with the development and persistence of obesity: a meta-analysis based on individual–participant data. *Obesity Reviews*, *14*(4), 315–323. http://doi.org/10.1111/obr.12007

Karnehed, N., Rasmussen, F., Hemmingsson, T., & Tynelius, P. (2006). Obesity and Attained Education: Cohort Study of More Than 700,000 Swedish Men. *Obesity*, *14*(8), 1421–1428. http://doi.org/10.1038/oby.2006.161

Kovalchik, S. (2009). Validity of adult lifetime self-reported body weight. *Public Health Nutrition*, *12*(08), 1072–1077. http://doi.org/10.1017/S1368980008003728

Kramer, A. F., & Erickson, K. I. (2007). Capitalizing on cortical plasticity: influence of physical activity on cognition and brain function. *Trends in Cognitive Sciences*, *11*(8), 342–348. http://doi.org/10.1016/j.tics.2007.06.009

Liu, S. Y., Buka, S. L., Kubzansky, L. D., Kawachi, I., Gilman, S. E., & Loucks, E. B. (2013). Sheepskin effects of education in the 10-year Framingham risk of coronary heart disease. *Social Science & Medicine*, *80*, 31–36. http://doi.org/10.1016/j.socscimed.2012.12.026

Liu, S. Y., Buka, S. L., Linkletter, C. D., Kawachi, I., Kubzansky, L., & Loucks, E. B. (2011). The Association Between Blood Pressure and Years of Schooling Versus Educational Credentials: Test of the Sheepskin Effect. *Annals of Epidemiology*, *21*(2), 128–138. http://doi.org/10.1016/j.annepidem.2010.11.004

Mirowsky, J., & Ross, C. E. (2003). *Education, Social Status, and Health*. Hawthorne, NY: Aldine de Gruyter.

Mitra, A. (2001). Effects of physical attributes on the wages of males and females. *Applied Economics Letters*, *8*(11), 731–735. http://doi.org/10.1080/13504850110047605

Montez, J. K., Hummer, R. A., & Hayward, M. D. (2012). Educational Attainment and Adult Mortality in the United States: A Systematic Analysis of Functional Form. *Demography*, *49*(1), 315–336. http://doi.org/10.1007/s13524-011-0082-8

Neumark-Sztainer, D., Story, M., & Harris, T. (1999). Beliefs and Attitudes about Obesity among Teachers and School Health Care Providers Working with Adolescents. *Journal of Nutrition Education*, *31*(1), 3–9. http://doi.org/10.1016/S0022-3182(99)70378-X

Orbach, S. (2006). Commentary: There is a public health crisis—its not fat on the body but fat in the mind and the fat of profits. *International Journal of Epidemiology*, *35*(1), 67–69. http://doi.org/10.1093/ije/dyi256

Provencher, V., Bégin, C., Gagnon-Girouard, M.-P., Tremblay, A., Boivin, S., & Lemieux, S. (2008). Personality traits in overweight and obese women: Associations with BMI and eating behaviors. *Eating Behaviors*, *9*(3), 294–302. http://doi.org/10.1016/j.eatbeh.2007.10.004

Puhl, R. M., & Latner, J. D. (2007). Stigma, obesity, and the health of the nation's children. *Psychological Bulletin*, *133*(4), 557–580. http://doi.org/10.1037/0033-2909.133.4.557

Rubin, D. B. (1987). Multiple Imputation for Nonresponse in Surveys. Wiley.

Von Hippel, P. T., & Lynch, J. L. (2014). Why are educated adults slim—Causation or selection? *Social Science & Medicine*, *105*, 131–139. http://doi.org/10.1016/j.socscimed.2014.01.004

Wardle, J., & Steptoe, A. (2003). Socioeconomic differences in attitudes and beliefs about healthy lifestyles. *Journal of Epidemiology and Community Health*, *57*(6), 440–443. http://doi.org/10.1136/jech.57.6.440

Weller, R. E., Cook III, E. W., Avsar, K. B., & Cox, J. E. (2008). Obese women show greater delay discounting than healthy-weight women. *Appetite*, *51*(3), 563–569. http://doi.org/10.1016/j.appet.2008.04.010

Table 3.1: Selection into education (ordinal logistic model)

Men	OR	95% C.I.	OR	95% C.I.
Underweight	0.93	0.68, 1.28	1.01	0.72, 1.41
Normal weight	----ref----		----ref----	
Overweight	0.93	0.76, 1.14	0.96	0.76, 1.21
Obese	0.77	0.49, 1.20	0.78	0.47, 1.28
Mother's education (years)			1.13	1.10, 1.17
Hispanic			1.33	1.06, 1.69
Black			1.78	1.48, 2.14
Aptitude test percentile			1.04	1.04, 1.05
Number of siblings			0.95	0.92, 0.98

Women	OR	95% C.I.	OR	95% C.I.
Underweight	1.33	1.06, 1.69	1.15	0.92, 1.46
Normal weight	----ref----		----ref----	
Overweight	0.59	0.47, 0.73	0.73	0.58, 0.92
Obese	0.36	0.23, 0.58	0.50	0.30, 0.83
Mother's education (years)			1.11	1.08, 1.14
Hispanic			1.41	1.15, 1.73
Black			2.26	1.89, 2.70
Aptitude test percentile			1.05	1.04, 1.05
Number of siblings			0.95	0.92, 0.98
Ever pregnant (age 17)			0.34	0.22, 0.50

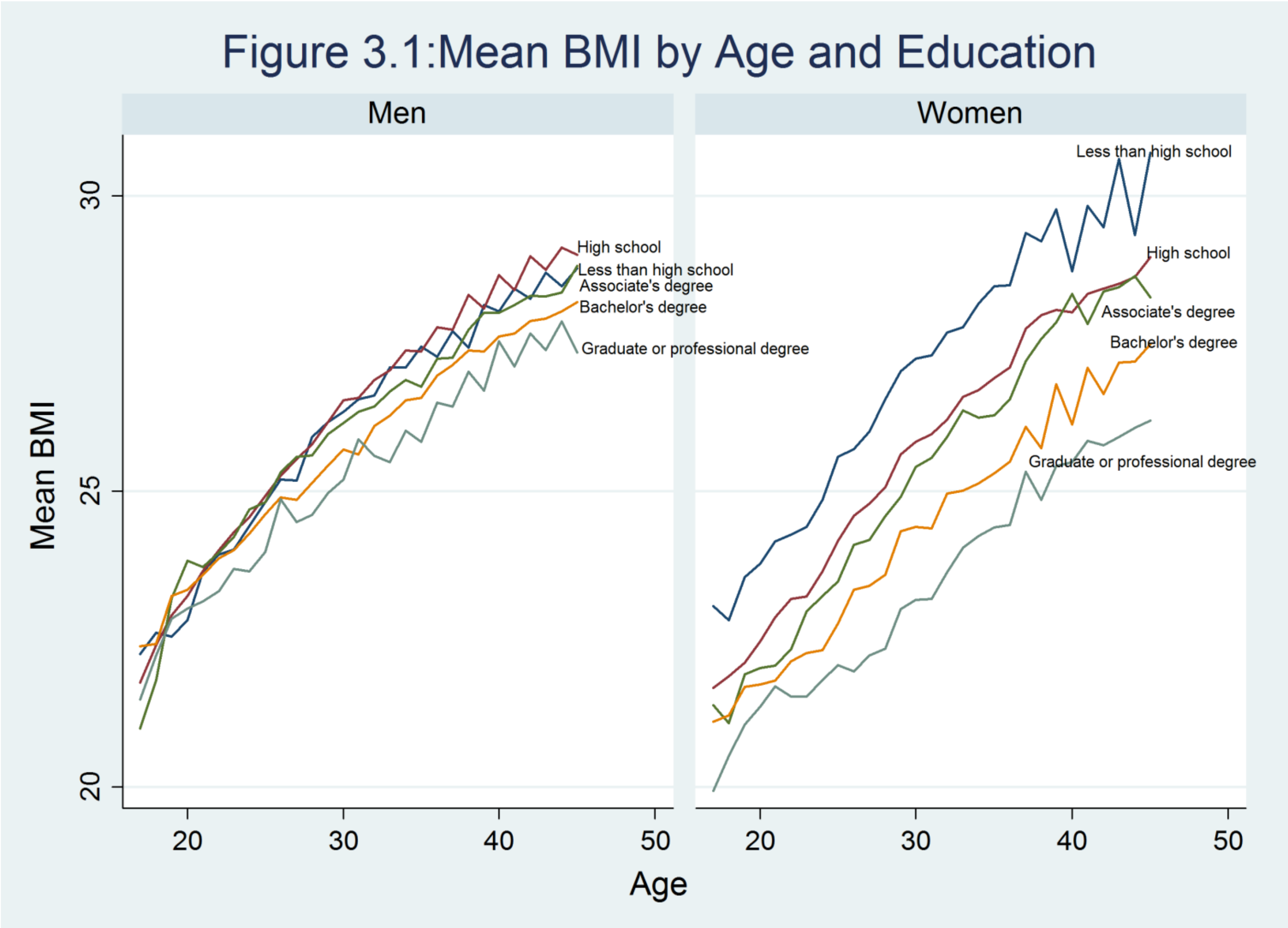
Figure 3.1:Mean BMI by Age and Education
Men
Women
Mean BMI
Age
20
25
30
20
30
40
50
High school
Less than high school
Associate's degree
Bachelor's degree
Graduate or professional degree

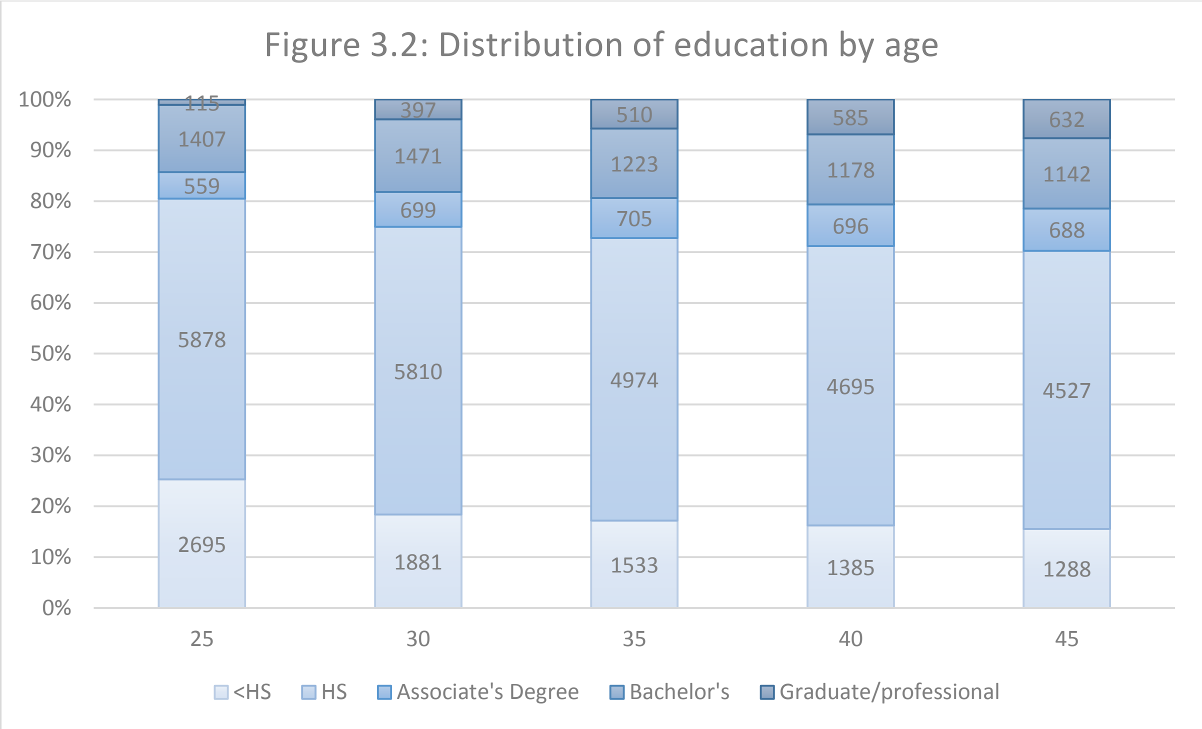

Figure 3.2: Distribution of education by age
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
115
1407
559
5878
2695
397
1471
699
5810
1881
510
1223
705
4974
1533
585
1178
696
4695
1385
632
1142
688
4527
1288
25
30
35
40
45
<HS
HS
Associate's Degree
Bachelor's
Graduate/professional

Table 3.2: Education and BMI at age 45 (men)

	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.‡	95% C.I.
High school	0.37	[-0.15,0.88]	0.5	[-0.10,1.10]	0.73*	[0.06,1.39]
Associate's degree	-0.05	[-0.65,0.54]	-0.05	[-0.68,0.57]	-0.03	[-0.68,0.62]
Bachelor's degree	-0.72**	[-1.19,-0.26]	-0.51*	[-1.00,-0.01]	-0.42	[-0.95,0.11]
Graduate or professional degree	-1.00**	[-1.73,-0.26]	-0.92*	[-1.68,-0.16]	-0.97*	[-1.78,-0.16]
Family income (log)			0.12	[-0.10,0.33]	0.51***	[0.22,0.80]
Parental education			-0.10**	[-0.16,-0.04]	-0.08*	[-0.14,-0.02]
Black			0.77***	[0.33,1.21]	0.72**	[0.26,1.18]
Hispanic			1.15***	[0.63,1.67]	0.90**	[0.36,1.44]
Previously married			-0.92***	[-1.38,-0.45]	-0.78**	[-1.26,-0.29]
Never married			-0.90***	[-1.41,-0.39]	-0.92***	[-1.46,-0.39]

* p<0.05, ** p<0.01, *** p<0.001 ‡ Model also controlled for occupational categories using 2000 coding scheme

Table 3.3: Education and BMI at age 45 (women)

	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.‡	95% C.I.
High school	-1.25**	[-2.00,-0.49]	0.16	[-0.68,1.01]	0.24	[-0.80,1.29]
Associate's degree	-0.17	[-0.84,0.49]	-0.1	[-0.78,0.58]	-0.5	[-1.23,0.24]
Bachelor's degree	-1.36***	[-1.96,-0.77]	-0.4	[-1.04,0.23]	-0.3	[-1.00,0.41]
Graduate or professional degree	-1.75***	[-2.68,-0.82]	-1.28**	[-2.25,-0.31]	-1.54**	[-2.60,-0.47]
Family income (log)			0.09	[-0.19,0.36]	-0.03	[-0.48,0.42]
Parental education			-0.25***	[-0.33,-0.17]	-0.26***	[-0.35,-0.17]
Black			2.87***	[2.31,3.43]	2.83***	[2.21,3.46]
Hispanic			1.00**	[0.33,1.67]	0.84*	[0.11,1.58]
Previously married			0.16	[-0.39,0.71]	0.18	[-0.44,0.79]
Never married			1.79***	[1.08,2.50]	1.92***	[1.15,2.70]

* p<0.05, ** p<0.01, *** p<0.001 ‡ Model also controlled for occupational categories using 2000 coding scheme

Table3.4: BMI and educational attainment (women)				
	FE		FE with covariates	
	Coeff.	95% C.I.	Coeff.	95% C.I.
High school	-0.1	(-0.25,0.05)	0.04	(-0.17,0.24)
Associates degrees	0.30*	(0.04,0.56)	0.32*	(0.03,0.62)
Bachelor's degrees	-0.16	(-0.37,0.05)	-0.30*	(-0.54,-0.06)
Graduate and professional degrees	-0.39*	(-0.71,-0.07)	-0.68***	(-1.04,-0.31)
Age (years)	0.55***	(0.52,0.59)	0.56***	(0.52,0.61)
Age squared	-0.00***	(-0.00,-0.00)	-0.00***	(-0.01,-0.00)
Has children			-0.09	(-0.26,0.08)
Net family income (log $)			0.00	(-0.06,0.07)
Married			0.42***	(0.30,0.54)
Unemployed			-0.11	(-0.26,0.03)
Out of labour force			0.28***	(0.17,0.40)

* p<0.05, ** p<0.01, *** p<0.001

Table 3.4 cont.				
	FEIS		FEIS with covariates	
	Coeff.	95% C.I.	Coeff.	95% C.I.
High school	-0.21**	(-0.33,-0.08)	-0.08	(-0.30,0.14)
Associates degrees	0.07	(-0.15,0.30)	0.26	(-0.12,0.63)
Bachelor's degrees	0.11	(-0.10,0.32)	0.08	(-0.17,0.34)
Graduate and professional degrees	0.24	(-0.05,0.53)	0.23	(-0.18,0.63)
Age (years)				
Age squared				
Has children			0.11	(-0.07,0.29)
Net family income (log $)			-0.01	(-0.07,0.06)
Married			0.54***	(0.42,0.67)
Unemployed			0.06	(-0.07,0.19)
Out of labour force			0.39***	(0.28,0.50)

* p<0.05, ** p<0.01, *** p<0.001

Table 3.5: BMI and educational attainment (men)				
	FE		FE with covariates	
	Coeff.	95% C.I.	Coeff.	95% C.I.
High school	0.20***	(0.09,0.32)	0.19**	(0.07,0.31)
Associates degrees	0.04	(-0.21,0.30)	-0.05	(-0.27,0.18)
Bachelor's degrees	-0.36***	(-0.51,-0.20)	-0.40***	(-0.55,-0.25)
Graduate and professional degrees	-0.37**	(-0.65,-0.09)	-0.38*	(-0.69,-0.07)
Age (years)	0.54***	(0.52,0.57)	0.52***	(0.48,0.55)
Age squared	-0.00***	(-0.01,-0.00)	-0.00***	(-0.00,-0.00)
Net family income (log $)			-0.05	(-0.11,0.02)
Married			0.35***	(0.28,0.42)
Unemployed			-0.01	(-0.10,0.08)
Out of labour force			0.09	(-0.03,0.20)

* p<0.05, ** p<0.01, *** p<0.001

Table 3.5 cont.				
	FEIS		FEIS with covariates	
	Coeff.	95% C.I.	Coeff.	95% C.I.
High school	0.05	(-0.04,0.15)	0.06	(-0.06,0.18)
Associates degrees	0.04	(-0.14,0.22)	0.06	(-0.13,0.25)
Bachelor's degrees	-0.1	(-0.26,0.06)	-0.08	(-0.27,0.11)
Graduate and professional degrees	0.29	(-0.20,0.79)	0.52	(-0.20,1.24)
Age (years)				
Age squared				
Net family income (log $)			-0.06	(-0.15,0.03)
Married			0.35***	(0.28,0.42)
Unemployed			-0.01	(-0.09,0.07)
Out of labour force			0.05	(-0.04,0.14)

* p<0.05, ** p<0.01, *** p<0.001

Chapter 4: The effect of delayed education

INTRODUCTION

In studying the relationship between socio-economic position and health, one of the frequently cited advantages of measuring socio-economic position with education is that after the mid-twenties it is stable across the life course (Duncan, Daly, McDonough, & Williams, 2002). However, social and economic changes going back several decades have lessened this stability. Increasing automation and the transference of production to emerging economies resulted in the redundancies of low-skilled employees and fewer positions available for new entrants to this labour market. Simultaneously, worker mobility increased, but in such a way that many workers moved into lower quality jobs (Doeringer, 1990). Over the same period women's participation in both education and paid work has also increased, even as they continue to bear the majority of responsibility as primary caregivers for children. As a result, many women's educational and career trajectories are punctuated and shaped by parental responsibilities. These trends towards increasing competition in the labour market and the interruption of education due to other life course events suggest that a non-trivial number of people might be inclined to further their education after age 25.

This is borne out by data on students in the US. 44% of all American adults reported participating in some type of formal education – excluding those studying full-time at universities or in vocational/technical training – in 2004/2005 (O'Donnell, 2006), and this number is likely to be higher when full-time students are included. In 2001, students over 22 made up 58% of all students seeking credit at community college and students over 24 made up more than 25% of first-time enrolees in community colleges in the US (Adelman, 2005). Educational institutions are attempting to make inroads into this growing market, both traditional brick-and-mortar institutions with established reputations such as the University of Wisconsin's Flexible Options program, and for-profit, online schools which market themselves entirely to those already in the workforce. In 2009, 42% of students at degree granting institutions in the United States were 25 years of age or older (U.S. Department of Education, National Center for Education Statistics, 2012). Of full-time students, those aged 25 or older made up 12% of students at public institutions and 14% of those at private non-profit institutions (National Center for Education Statistics, US Department of Education, 2014). 24-29 year olds made up 19.4% of first-time degree recipients in 2008, and a further 13.3% of degree recipients were aged 30 or older (Woo, Green, & Matthews, 2013). Less data are available on non-traditionally aged students' participation in high school or equivalent education. Based on trends in participation in higher education, it seems the assumption that education is a static measure after the mid-twenties is unrealistic. This means that those interested in the relationship between education and health may do well to consider the *timing* of education within the lifecourse.

Do non-traditionally aged students experience the same health benefits as their traditionally-aged peers? This largely depends on how education is related to health. One of the primary causal hypotheses suggests that education enables maintenance or advancement of social and economic position. Education leads to higher status and higher paying jobs which are associated with healthier lifestyles. This is particularly important in thinking about obesity because higher income provides access to more nutritious food which is expensive relative to high calorie, nutrient-poor food(Drewnowski, 2010; Drewnowski & Darmon, 2005). Previous research suggests that non-traditional students may not experience the same income benefits as those who complete their studies "on time". GED holders (a group who typically attains this qualification later than their peers earn their high school diplomas) have economic outcomes more like non-completers than holders of high school diplomas (Cameron & Heckman, 1991). In one study women who earned bachelor's degrees after they had started their first post-secondary job experienced an increase in wages, whereas women earning associates or graduates degrees, and men earning any degree experienced no such benefit (Elman & O'Rand, 2004). Another study employing fixed effects found that completion of a degree after age 25 did not provide the same wage premium as on-time completion (Taniguchi, 2005). If the health benefits of education operate through income then it seems likely those who complete their education later than the normative age will not gain the same advantage.

A second mechanism through which education is thought to affect health is by increasing perceived self-efficacy or "learned effectiveness" (Mirowsky & Ross, 2003). Education increases learned effectiveness by providing both tangible skills and practice at problem solving. According to Mirowsky and Ross, this enables individuals who value health to lead healthy lifestyles because such experiences will lead those with education to believe their health (among other things) is within their control and to use their enhanced problem solving skills in order to incorporate healthy behaviours into their lives. Intuition suggests that in the pathway education→ perceived self-efficacy → health behaviour, the first link is more likely than the second to be affected by age or life course timing of education. However, neither theory nor previous empirical studies provide guidance as to whether this link does in fact vary according to the age at which education is completed. It is also plausible that one's sense of control or self -efficacy is a determinant rather than a result of educational attainment.

Other explanations for the relationship between education and health – or obesity – centre on selection processes. Those who attain higher levels of education differ from those who do not, and those differences, rather than the education gained, explain variation in health. In studies of obesity and body weight such processes have been demonstrated. The results I present in chapter two show that selection effects are present in the NLSY79 sample, with BMI at age 17 predictive of educational attainment at age 45. Selection may also lead to different outcomes for those who complete education late and on time. Just as those who pursue education may differ in important ways from those who do not, those who complete education "late" may differ in important ways from both those who complete their education on time and from those who do not attain the same level of education. This is supported by the literature; factors associated with re-entering education include being from a higher SES family of origin, early motherhood (for women), military experience (for men), (Elman & O'Rand, 2004, 2007), initial educational status (more highly educated more likely to participate according to Creighton & Hudson, 2002; less educated more likely according to Elman & O'Rand, 2004), divorce (for women) (Taniguchi & Kaufman, 2007) and perceived job insecurity (Elman & Weiss, 2014).

Separately from education's effect on health behaviour and the possibility of selection effects, lifecourse epidemiology suggests that altering health trajectories may be more difficult with increasing age due to the interaction of socio-ecological exposures and physiological pathways. The cumulative (dis)advantage hypothesis suggests that physiological effects of exposure to disadvantage, in this case low education, accumulate over time (Ben-Shlomo & Kuh, 2002). In the socio-ecological dimension, the years spent at lower educational status are years when an individual was making fewer investments in her health. Years prior to re-joining the educational system would likely have been spent with lower sense of control and subsequently higher stress. Those undertaking education at the normative life stage would not face this exposure and so their body weight may be more responsive to changes in health behaviours. Moreover, at the traditional ages, educational milestones coincide with periods where young adults are first gaining independence and establishing their own values, lifestyles, and social networks. In contrast, mature students are likely to have already established these, and so their health behaviours may be less likely to be shaped by their education.

These social and behavioural factors interact with the underlying physiological trajectory of BMI over the lifecourse. Previous studies have identified several trajectories of BMI from early adulthood with variation in both linear and quadratic associations with age (for example, see Østbye, Malhotra, & Landerman, 2011). Some of these trajectories involve relatively rapid growth in BMI through the twenties followed by much slower growth. This may mean that later education has less scope to change BMI trajectory than does earlier education, resulting in smaller effect sizes that may not be detectable. In addition, weight loss requires overcoming biofeedback that becomes more established with increasing age (before the onset of weight loss associated with old age). Weight loss at an older age is made more difficult than at a relatively younger age by a slowed metabolism, and by a longer period during which the body has been geared towards either weight maintenance or weight gain. Powerful biofeedback loops, for example satiety signals, become more established over time. On the other hand, it may be easier to lose weight as one's maximal weight is approached, which typically occurs after middle age. Those who are slightly overweight in their twenties could healthily lose a small amount of weight, while those who have gained weight over two or three decades can afford to lose a larger amount of weight. While this is less common, this may be detected as a stronger effect than a potentially more common but much smaller weight loss.

To my knowledge, no study has directly examined the effects of delayed education on obesity. A study comparing GED holders, traditional high school graduates, and high school non-completers may offer some insight as GED holders are likely to comprise a large number of late-completers. One such study found the returns to the GED in terms of obesity and smoking were lower than the returns to high school graduation (Kenkel, Lillard, & Mathios, 2006). Only a few studies have considered any health outcomes related to late education. GED holders aged 50 years and older had greater odds of difficulties with instrumental activities of daily living than did high school graduates yet similar odds to non-graduates (Liu, Chavan, & Glymour, 2013).

Walsemann et al (2012) followed a sub-sample of the NLSY79 who had not earned degrees at age 25, and found that at age 45 those who subsequently earned degrees had fewer depressive symptoms. This finding is what would be expected of education undertaken at a traditional age, but –like much research on education and health – cannot ensure that education preceded the health outcome of interest. In a study of military retirees, Edwards (2010) found that the health benefits of education decline with increasing age during education, despite the association between education and economic indicators being relatively unchanged by education's timing. A British study found that qualifications earned after age 23 lowered the risk of coronary heart disease among women regardless of initial education level and among men who initially had low levels of education (Chandola, Plewis, Morris, Mishra, & Blane, 2011).

Later education leads to more modest economic advantages, and requires at least some exposure to life as a less educated person. Even so, later education may still offer some benefits compared to remaining at the same level of education. Gaining a qualification, even late, may improve perceived self-efficacy, and improve income and social standing. In addition, differences in obesity may be detected between those who undertake education later than is normative and those who remain relatively less educated due to other differences between these groups. In this study I examine whether 1) there is a difference in age 45 BMI between those who attained a given level of education at different ages, and 2) the extent to which such an effect is plausibly causal.

METHODS

Data

This study uses the National Longitudinal Study of Youth 1979 data, described in Chapter 2.

MEASURES

Dependent variable – BMI Body mass index (BMI) is derived by calculating weight in kilograms divided by the square of height in meters.

Independent variable – Education For levels of education of high school, associate's degree, and bachelor's degree or higher, three-level ordinal variables indicated whether respondents had earned the qualification on time, late, or never. For high school qualifications and equivalent, "late" was defined as attaining the qualification at age 23 or later. This was necessary because the oldest members of the panel entered the study at age 22 and so setting the threshold for "on time" completion earlier would result in large amounts of missing data. For associate's degrees and bachelor's degrees, "on time" was defined as completion by age 26. There is some precedent in public policy to consider age 26 the normative upper age limit for tertiary education; for example, the Affordable Care Act includes a provision whereby students who are aged 26 or younger may remain covered by their parent's or parents' health insurance. Further, age 26 was the median age of bachelor's degrees for women. No separate variable was created to indicate the attainment of graduate or professional degrees because it is not clear that there are norms about when in the lifecourse such education would be completed and there is likely to be considerable heterogeneity. For example, MD and JD degrees are often completed immediately after undergraduate degrees, while other qualifications such as the MBA or EdD are more likely to be undertaken mid-career to facilitate promotion and advancement.

Analytic Strategy

The existence and magnitude of differences in BMI by educational attainment and educational timing were first established with a cross-sectional analysis at age 45, the oldest age for which the youngest members of the panel had data. The linear regression model describing the relationship between education group and BMI at age 45 is:

$$BMI=\beta_0+\beta_1\text{on-time hs}+\beta_2\text{late hs}+\beta_3\text{on-time associate's}+\beta_4\text{late associate's}+\beta_5\text{on-time bachelor's}+\beta_6\text{late bachelor's}+\varepsilon \quad (1)$$

A more interesting question than whether the BMI of the three groups differs at age 45 is whether BMI trajectories of those who attained educational qualifications at different times changed as a result of earning these qualifications. To address this question I used fixed effects models. Fixed effects models ensure the correct temporal order of exposure (qualification attainment) and outcome (BMI) and are not susceptible to bias caused by fixed characteristics that differ between individuals. This is accomplished by modelling how a change in educational status is related to a subsequent change in BMI for each individual. Because BMI tends to increase with age, it is also necessary to control for age in the model. In order to determine the functional form of the relationship between age and BMI, I created fixed effects models using four specifications of age to predict BMI: 1) linear, 2) linear + quadratic, 3) natural log, 4) linear + square root. The best specification was considered to be the model with the highest within-R^2 or the specification which explained the greatest portion of intra-individual variation in BMI. Table 4.1 shows the results of this comparison.

For women, the best fitting age specification was a combination of a linear and a quadratic term while for men this was a combination of a linear and square root term. A linear+quadratic specification was the second best performing for men, and only differed from the optimal linear+square root by 0.0004. Thus the linear + quadratic specification was incorporated into fixed effects models, with the fixed effects model specification as follows:

$$BMI_{ij}=\beta_0+\beta_1\text{on-time hs}_{ij}+\beta_2\text{late hs}+\beta_3\text{on-time associate's}_{ij}+\beta_4\text{late associate's}_{ij}+\beta_5\text{on-time bachelor's}_{ij}+\beta_6\text{late bachelor's}_{ij}+\beta_7\text{age}_{ij}+\beta_8\text{age-squared}_{ij}+u_i+\varepsilon_{ij} \quad (2)$$

In model (2), the composite error term comprises ε_{ij}, representing random error, and u_i, representing time invariant individual characteristics, for example, one's genetic propensity to gain weight. The fixed effects model is thus not biased by individual heterogeneity that is time invariant even if it is correlated with the independent variables, but it does assume homogeneity in slopes between individuals. More formally, the fixed effects model assumes that the BMI trajectories of different treatment groups would be parallel absent the intervention. To relax this assumption, a third error term is added to the model. The u_i can be thought of as individual intercepts, and the new third component of the error term can be thought of as individual slopes (Brüder & Ludwig, 2014). Again, these individual slopes may be correlated with the independent variables. These individual slopes interact with time, in this case the linear and quadratic age terms, to give:

$$BMI=\beta_0+\beta_1 \text{on-time hs}+\beta_2 \text{late hs}+ \beta_3 \text{on-time associate's}+\beta_4 \text{late associate's} +\beta_5 \text{on-time bachelor's} +\beta_6 \text{late bachelor's} + u_{1i}+ u_{2i}{*}\text{age} + u_{3i}{*}\text{age squared} +\varepsilon_{ij} \quad (3)$$

To implement the fixed effects with individual slopes (FEIS) model, a user-written Stata command was obtained directly from its creator, Viktor Ludwig.[2] Versions of models (2) and (3) were run with and without adjustment for time-varying predictors including marital status, employment status, family income, and, for women, having children.

Education policy agendas are not generally set with population health in mind, the public health community's own "health in all policies" agenda notwithstanding. There is little policy debate about whether earning the high school diploma confers advantage. However, there is heated debate about the benefit of higher education and expanding access to this. There has been inflation in the qualifications necessary for various types of employment such that tertiary qualifications are necessary where they were not previously. The White House has recently advocated that everyone undertake some measure of post-secondary education, and proposed making community college free with a combination of Federal and state funding for up to two years in order to facilitate this. With this background, the meaningful public health question is not simply whether education is beneficial, but whether high school graduates would benefit from further education, especially if several years have passed since they completed high school. To answer this question, I reran models (2) and (3) on the subsample who already had high school diplomas or equivalent.

[2] xtfeis.ado by Volker Ludwig. Further information available at http://www.stata.com/meeting/germany10/germany10_ludwig.pdf.

It is possible that the effects of education are not a one-time change in BMI but instead or in addition a change in BMI growth over time. This can be detected by an interaction between the education terms and age:

BMI_{ij}=β_0+ $\beta_1$on-time hs_{ij}+$\beta_2$late hs+ $\beta_3$on-time associate's$_{ij}$+$\beta_4$late associate's$_{ij}$ +$\beta_5$on-time bachelor's$_{ij}$ +$\beta_6$late bachelor's$_{ij}$ + $\beta_7$on-time hs*age+$\beta_8$late hs*age+ $\beta_9$on-time associate's*age+β_{10}late associate's*age +β_{11}on-time bachelor's*age +β_{12}late bachelor's *age+ β_{13}on-time hs*age squared+β_{14}late hs*age squared+ β_{15}on-time associate's*age squared+β_{16}late associate's*age squared +β_{17}on-time bachelor's*age squared +β_{18}late bachelor's *age squared + β_{19}age$_{ij}$+ β_{20}age-squared$_{ij}$ +u_i+ε_{ij}
(4)

BMI=β_0+$\beta_1$on-time hs+$\beta_2$late hs+ $\beta_3$on-time associate's+$\beta_4$late associate's +$\beta_5$on-time bachelor's +$\beta_6$late bachelor's + $\beta_7$on-time hs*age+$\beta_8$late hs*age+ $\beta_9$on-time associate's*age+β_{10}late associate's*age +β_{11}on-time bachelor's*age +β_{12}late bachelor's *age+ β_{13}on-time hs*age squared+β_{14}late hs*age squared+ β_{15}on-time associate's*age squared+β_{16}late associate's*age squared +β_{17}on-time bachelor's*age squared +β_{18}late bachelor's *age squared + u_{1i}+ u_{2i}*age + u_{3i}*age squared +ε_{ij}
(5)

It is important to assess whether those who attained qualifications on time, late, or never differ in any of the measured characteristics, as previous studies suggest. I first used a multinomial logistic regression to compare the effects of marital status, income, employment status, and, for women, having children, at age 44 or 45 on the probability of 1) not gaining a qualification and 2) gaining a qualification on-time relative to the probability of gaining a qualification late. I then used fixed effects logistic regression to find the effect of change in marital status, income, employment status, and motherhood on the odds of qualification attainment. The fixed effects model is:

$\ln(\frac{p_{qualificaion}}{p_{no\ qualification}})$= β_0+$\beta_1$never married$_{it}$+$\beta_2$previously married$_{it}$+ $\beta_3$log income$_{it}$ +$\beta_4$unemployed$_{it}$ + $\beta_5$out of labour force$_{it}$ + (β_6 has children$_{it}$ +) $\beta_7$age$_t$+$\beta_8$age-squared$_t$+ u_i (6)

The model was repeated with four different dependent variables: on-time high school diplomas, late high school diplomas, early bachelor's degrees, and late bachelor's degrees. The sample was limited to those in the appropriate age range for each dependent variable, i.e. older or younger than 22 for high school and older or younger than 26 for degrees. Because life events triggering a return to education would be expected to happen prior to qualification receipt, the models were also run with a 2 year lag in the predictors.

RESULTS

In addition to the descriptive statistics presented in chapter 2, a detailed overview of the education histories of the sample who remained in 2010 are presented in Table 4.2. The highest proportion of "late" qualifications were high school diplomas or equivalent, with 12.3% of men and 10.8% of women earning these qualifications late. The smallest proportion earned associate's degrees "late", with 3.3% of men and 4.7% of women earning these qualifications after age 26. Associates degrees had a median age of completion of 28 for men and 28.5 for women, meaning that more than 50% of associate's degrees were earned "late".

Tables 4.3 and 4.4 show how characteristics of the sample in middle age predict the probability of having earned a degree after age 26. Values in the table are relative risks of either earning no degree or earning a degree on time. In both cases the probability is relative to the probability of having earned a degree after age 26. Women whose parents had more years of education, who scored higher on an aptitude test in 1979, who were Black or Hispanic, and who had higher net family income at age 44 or 45 were less likely to not have earned a degree, while women with children were more likely to not have earned a degree. Women with more highly educated parents and women who scored higher on an aptitude test were more likely to earn a degree by age 26 while women who were Hispanic were less likely to earn a degree by age 26. Men with more highly educated parents, higher test scores, higher income, and men who were black were less likely to earn no degree, while men with higher test scores were more likely to earn a degree before age 26.

In fixed effects models identifying predictors of qualification attainment, having children and being separated, divorced, or widowed were rare resulting in odds ratios five to six orders of magnitude larger than other OR estimates. This was also the case for having children predicting late high school completion in the contemporaneous model for women. These predictors were subsequently omitted from the affected models.

In fixed effects models predicting early qualifications women's and men's odds of earning a high school diploma either on time or late were unaffected by the predictors included in the model (tables 4.5 and 4.6). Table 4.7 shows that having children greatly reduced women's odds of earning a degree after age 26, although this effect was not significant in the lagged model. Being out of the labour force reduced women's odds of earning a degree at any time, but in lagged models this effect was not significant for late degrees and increased the odds of earning a degree on time. An increase in income two years prior lead to increased odds of earning a degree after age 26. No included time-varying characteristics predicted women earning high school diplomas either late or on time. As table 4.8 shows, the end of a marriage led to men having lower odds of earning a degree – early or late – two years later. Men who were out of the labour force had lower odds of earning a degree either early or late, and men who had never been married had lower odds of earning a degree early. Most of the statistically significant associations suggested that the odds of earning a degree were reduced by the relevant predictor. The exceptions to this were women whose family income had increased two years prior had higher odds of earning a degree after age 26, and women who exited the labour force to years prior had higher odds of earning a degree by age 26.

Tables 4.9 and 4.10 show the results of linear regressions of education category against BMI at age 44 or 45. Women who gained high school diplomas or equivalent before age 22 had lower BMI in their mid-40s than women without high school or equivalent qualifications, but women who gained their high school qualifications late did not have statistically different BMIs than women without such credentials. Women with associates degrees had higher BMI at age 45 than women without associates degrees, regardless of whether the degree was earned on time or late, while women with bachelor's degrees had lower BMI at age 45 regardless of when the degree was earned. Post-estimation testing did not detect significant differences between the coefficients for early vs late associate's degrees or early vs late baccalaureate degrees when applying a Bonferroni correction for testing multiple hypotheses. Men who earned high school diplomas on time or associate's degrees late had higher BMI at age 45 than men who had never earned high school diplomas or associate's degrees respectively, while there was no difference in BMI at age 45 between men who had earned bachelor's degrees at any age and those who had not. Fixed effects models are shown in tables 4.11 and 4.12. For men, regular fixed effect models suggest that high school diplomas earned on time lead to increased BMI while bachelor's degrees earned on time lead to a reduction in BMI. When individual slopes are included in the model, no level of education earned at any time is significant. Under the regular fixed effects assumptions, women who earn associate's degrees late experience a *gain* in BMI while women who earn bachelor's degrees on time experience a reduction in BMI. Upon including individual slopes in the fixed effects models earning either high school or bachelor's qualifications on time precedes a loss (or reduced gain) in a woman's BMI, while earning a baccalaureate late precedes a gain in BMI. When the sample is restricted to those already holding high school diplomas or equivalent, similar results are apparent. Men who earn bachelor's degrees on time have lower BMI under the fixed effects model but relaxing the parallel trends assumption by including individual slopes attenuates this effect. Women who earn bachelor's degrees on time appear to benefit under both the regular fixed effects model and the model including individual slopes, and women who earn bachelor's degrees late experience an increase in BMI. Tables 4.13 and 4.14 show that when the effects of marital status, employment status, income, and for women, having children, the loss of weight associated with earning a degree on time is no longer statistically significant, while the increase in BMI associated with women earning a degree late remains.

Compared to the associations shown in the cross-sectional models, the apparent effect of education on BMI is greatly reduced in the fixed effects models, with many associations disappearing, and, in the case of women earning bachelor's degrees late, the direction of the effect reversing. When the effect was maintained in fixed effects models, for example, early completion of bachelor's degrees for women, the magnitude of the effect was much smaller.

Appendix 4.1 shows the result of models that include interaction terms. FE models suggest negative BMI growth in women who earn degrees early, while FEIS models suggest positive BMI growth in women who earn high school diplomas in the unadjusted model.

DISCUSSION

Characteristics of early and late completers

Previous studies have found that among those who did not have a degree at the traditional age, degree attainment later was associated with parental education, income, divorce, and having children (Elman & O'Rand, 2004, 2007; Taniguchi & Kaufman, 2007). The cross-sectional multinomial logistic model was largely consistent with these findings, although being previously married (i.e. separated, divorced, or widowed) did not appear to effect the probability of earning a degree late relative to either the probability of not earning a degree or earning a degree on time. However, the fixed effects models found few time varying predictors were related to the odds of earning either degrees or high school diplomas at any stage. In the case of degrees, this may be because relatively few people earned degrees either on time or late, resulting in quite wide confidence intervals. Were estimates more precise, some other predictors of earning degrees on time or late may have emerged. However, there were a much larger number of high school graduates and so a lack of power is less likely to explain the lack of predictive power of the variables included in these models.

The difference between cross sectional and longitudinal results suggests that rather than certain lifecourse events such as entering or leaving marriage or having children motivating people to return to education, these events may share a common cause with returning to education. For example, someone may wish to accomplish particular goals before earning a degree and before committing to marriage. The difficulty posed for subsequent analysis is that it is not known whether these underlying motivations are time-invariant. If the motivations do not change over time, then the fixed effects models of the effect of early and late education will not be affected. On the other hand, if they do change over time then apparent differences in BMI after earning qualifications early or late may in fact be attributable to a selection effect. There are plausible scenarios of both time-varying and time-invariant motivations, but it is not possible to test which is occurring with these data.

Effects of late education

As an increasing number of people beyond the age when education is typically thought to be complete are participating in education, can they expect improvements in their health, and particularly protection against weight gain? In this chapter, different statistical strategies have produced often conflicting answers to this question.

The first set of models presented are cross-sectional models using data collected when participants were 44 or 45 years old. In regressing BMI in middle age against education categories, these models address the question, *is there a difference in BMI between those with qualifications earned at the traditional age, those with qualifications earned later than is traditional, and those without qualifications?* For women, there are some differences. Bachelor's degree holders have lower BMIs than non-degree holders, while associate's degree holders have higher BMIs than those without degrees. For neither degree type does it matter whether the degree was earned on time or late. However, women with high school diplomas only have lower BMIs than high school dropouts if the high school diploma was earned by age 22.

The fixed effects models ask *does gaining a given qualification, either on time or late, lead to a change in BMI?* Models that included individual slopes found that when women earned high school diplomas or bachelor's degrees – but not associate's degrees – on time, they experienced a reduction in BMI, whereas men did not experience any change in BMI after gaining qualifications either early or late. Comparing the cross sectional results to the fixed effects results leads to several observations. Firstly, the positive associations seen in the cross sectional models disappear in the fixed effects models (with the exception of late bachelor's degrees when the sample is limited to those holding high school diplomas or equivalent, which I discuss below). Women who earn associate's degrees, for example, should not expect to gain weight as a result; the higher predicted BMI of associate's degree holders may have already been in place before their graduation. Secondly, in the cross sectional model all women who had earned bachelor's degrees had lower predicted BMI than those without, whereas the longitudinal analysis found that only women who earned the degree on time experienced a benefit. That is, the timing effect is apparent only in the longitudinal models. Finally, in the case of women who earned their high school diplomas on time, the coefficient estimate was reduced by more than two-thirds from 0.88 kg/m^2 in the cross-sectional model to 0.25 kg/m^2 in the FEIS model.

The FEIS model tells a very different story about the effects of education and education timing on men's education that do either the cross sectional or regular FE model. At age 45, men who earned high school diplomas or GEDs on time, or associate's degrees late, have higher BMI than men without high school diplomas or associate's degrees respectively. The fixed effects model suggests that earning high school diplomas or associate's degrees at any age will lead to increased BMI, while bachelor's degrees earned on time but not late will lower it. However, with the inclusion of individual slopes in the model, some of this effect is attenuated. Adding control variables to the FEIS models resulted in the effect of bachelor's degrees earned by age 26 no longer being statistically significant. However, the point estimates were virtually unchanged; only the standard error increased. This may be due to a reduction in power as some observations were dropped due to missing data in the additional variables.

The FEIS results presented here suggest that women, but not men, with high school diplomas or equivalent may benefit from gaining bachelor's degrees by their mid-twenties. These results also suggest that women who earn bachelor's degrees late appear to gain bodyweight; however, this is likely to be explained by omitted variables such as interrupting education due to pregnancy and child rearing rather than the receipt of a bachelor's degree causing weight gain.

These results differ somewhat from those of the previous chapter. There are similarities in that FEIS models in chapter 2 and the current chapter both found that men did not experience any reduction in BMI after gaining qualifications. In chapter 2, FEIS models exploring the effect of different levels of education found that for women, only high school completion was important in predicting BMI. The present model suggests not only that completion of high school by age 22 is important, but that the completion of baccalaureate qualifications by age 26 is also important. The difference between the two results lends support to the idea that the timing of education is important over and above the qualification itself, at least for baccalaureate degrees. Grouping those who earned their degrees late with those who earned their degrees on time results in a small net effect that is not statistically distinct from no effect. Separating those who earned degrees on time from those who earned them late reduced heterogeneity; conceptually, this can be viewed as removing a measurement error in combing two groups that are distinct. By using more meaningful categories of educational grouping the effect of bachelor's degrees is not diluted and can be detected by the FEIS model.

The lack of a significant benefit for women who earned high school diplomas or bachelor's degrees late provide some support the hypothesis that the protective effects of these educational qualification are dependent on attaining them at the "normal" stage in life, in turn suggesting that education's effects on health behaviour are less strong later in life. Education at the typical ages is likely to be a more immersive experience (Gilardi & Guglielmetti, 2011) and thus exhibit stronger effects on behaviour than education undertaken later. Physiological differences are also a possibility. For example, metabolism slows with age and so even if education had identical effects on diet and exercise at all ages, the subsequent effect on body weight would decline with increasing age. Moreover, the body has established set points with regards to weight involving complex biofeedback, for example, satiety signals. Older students, relative to traditional age students, have more accumulated years of behavioural habits and physiological processes to change.

Limitations

An important limitation of these analysis is that the data do not reveal the educational institution where the qualification was earned. There is likely to be a difference in selectivity and educational quality between the institutions attended by traditional-aged students versus those who are studying part-time or returning after an absence. For-profit institutions, for example, actively target returning students by offering credit for life-experience. Even among not-for-profit institutions, traditionally aged students are more likely to actively seek out elite institutions, while older students are more likely to prioritise geography than institutional quality.

Another limitation may be that low numbers of participants completed their education late, meaning the study may not have adequate power to detect a change in BMI after earning qualifications late and thus create the appearance that degrees earned on time are more beneficial than those earned late. Both FE and FEIS models were able to detect a moderate (approximately 0.70 kg/m^2) increase in BMI following the late receipt of bachelors' degrees for women. However, smaller effects may not be detected as discussed above in relation to the effect of degrees earned on time.

Conclusions

The education gradient in BMI appears sensitive to the age at which education was completed, although the possibility that this is due to differences between those who complete their education on time and those who do so late cannot be ruled out. Non-traditionally aged students make up an increasing proportion of American students, but it does not seem that they gain the same protection against weight gain as their traditionally aged peers. These findings could lend support to both timing and accumulative processes of life course epidemiology. To the degree that education improves health outcomes such as obesity, it seems that these effects are time limited in the life course. Spillover effects on the obesity epidemic of education policies seeking to increase participation in post-secondary education are unlikely to benefit non-traditional aged students.

REFERENCES

Adelman, C. (2005). *Moving into Town--and Moving On: The Community College in the Lives of Traditional-Age Students*. Washington D.C.: US Department of Education. Retrieved from http://eric.ed.gov/?id=ED496111

Ben-Shlomo, Y., & Kuh, D. (2002). A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *International Journal of Epidemiology*, *31*(2), 285–293. http://doi.org/10.1093/ije/31.2.285

Brüder, J., & Ludwig, V. (2014). Fixed effects panel regression. In H. Best & C. Wolf (Eds.), *The SAGE Handbook of Regression Analysis and Causal Inference* (pp. 331–361). London: SAGE Publications Ltd.

Cameron, S. V., & Heckman, J. J. (1991). *The Nonequivalence of High School Equivalents* (Working Paper No. 3804). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w3804

Chandola, T., Plewis, I., Morris, J. M., Mishra, G., & Blane, D. (2011). Is adult education associated with reduced coronary heart disease risk? *International Journal of Epidemiology*, *40*(6), 1499–1509. http://doi.org/10.1093/ije/dyr087

Creighton, S., & Hudson, L. (2002). *Participation Trends and Patterns in Adult Education: 1991-1999. Statistical Analysis Report.* Washington D.C.: National Center for Education Statistics, US Department of Education. Retrieved from http://eric.ed.gov/?id=ED463449

Doeringer, P. B. (1990). Economic security, labor market flexibility, and bridges to retirement. In P. B. Doeringer (Ed.), *Bridges to Retirement: Older Workers in a Changing Labor Market* (pp. 3–19). Ithaca, NY: Cornell University Press.

Drewnowski, A. (2010). The Cost of US Foods as Related to Their Nutritive Value. *The American Journal of Clinical Nutrition*, *92*(5), 1181–1188. http://doi.org/10.3945/ajcn.2010.29300

Drewnowski, A., & Darmon, N. (2005). Food Choices and Diet Costs: an Economic Analysis. *The Journal of Nutrition*, *135*(4), 900–904.

Duncan, G. J., Daly, M. C., McDonough, P., & Williams, D. R. (2002). Optimal Indicators of Socioeconomic Status for Health Research. *American Journal of Public Health*, *92*(7), 1151–1157. http://doi.org/10.2105/AJPH.92.7.1151

Edwards, R. D. (2010). *Health, Income, and the Timing of Education Among Military Retirees* (Working Paper No. 15778). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w15778

Elman, C., & O'Rand, A. M. (2004). The Race Is to the Swift: Socioeconomic Origins, Adult Education, and Wage Attainment. *American Journal of Sociology*, *110*(1), 123–160. http://doi.org/10.1086/386273

Elman, C., & O'Rand, A. M. (2007). The effects of social origins, life events, and institutional sorting on adults' school transitions. *Social Science Research*, *36*(3), 1276–1299. http://doi.org/10.1016/j.ssresearch.2006.11.001

Elman, C., & Weiss, F. (2014). Adult educational participation and implications for employment in the US context. In H.-P. Blossfeld, E. Kilpi-Jakonen, D. Vono de Vilhena, & S. Buchholz (Eds.), *Adult Learning in Modern Societies: An International Comparison from a Life-course Perspective*. Edward Elgar Publishing.

Gilardi, S., & Guglielmetti, C. (2011). University Life of Non-Traditional Students: Engagement Styles and Impact on Attrition. *The Journal of Higher Education*, *82*(1), 33–53.

Kenkel, D. S., Lillard, D. R., & Mathios, A. D. (2006). *The Roles of High School Completion and GED Receipt in Smoking and Obesity* (Working Paper No. 11990). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w11990

Liu, S. Y., Chavan, N. R., & Glymour, M. M. (2013). Type of High-School Credentials and Older Age ADL and IADL Limitations: Is the GED Credential Equivalent to a Diploma? *The Gerontologist*, *53*(2), 326–333. http://doi.org/10.1093/geront/gns077

Mirowsky, J., & Ross, C. E. (2003). *Education, Social Status, and Health*. Hawthorne, NY: Aldine de Gruyter.

National Center for Education Statistics, US Department of Education. (2014). *Characteristics of Postsecondary Students*.

O'Donnell, K. (2006). *Adult education participation in 2004-05 (NCES 2006-077)*. Washington, D.C.: National Center for Education Statistics, US Department of Education. Retrieved from http://www.voced.edu.au/content/ngv40658

Østbye, T., Malhotra, R., & Landerman, L. R. (2011). Body mass trajectories through adulthood: results from the National Longitudinal Survey of Youth 1979 Cohort (1981–2006). *International Journal of Epidemiology*, *40*(1), 240–250. http://doi.org/10.1093/ije/dyq142

Taniguchi, H. (2005). The Influence of Age at Degree Completion on College Wage Premiums. *Research in Higher Education*, *46*(8), 861–881. http://doi.org/10.1007/s11162-005-6932-8

Taniguchi, H., & Kaufman, G. (2007). Belated entry: Gender differences and similarities in the pattern of nontraditional college enrollment. *Social Science Research*, *36*(2), 550–568. http://doi.org/10.1016/j.ssresearch.2006.03.003

U.S. Department of Education, National Center for Education Statistics. (2012). *The Condition of Education 2012 (NCES 2012-45) Indicator 47*. U.S. Department of Education, National Center for Education Statistics.

Walsemann, K. M., Bell, B. A., & Hummer, R. A. (2012). Effects of Timing and Level of Degree Attained on Depressive Symptoms and Self-Rated Health at Midlife. *American Journal of Public Health*, *102*(3), 557–563. http://doi.org/10.2105/AJPH.2011.300216

Woo, J., Green, C., & Matthews, M. (2013). *Profile of 2007-08 First-Time Bachelor's Degree Recipients in 2009*. Washington D.C.: National Center for Education Statistics, US Department of Education.

Table 4.1: Within-R^2 for various specifications of age

	Women	Men
Linear	0.3139	0.3819
Linear + quadratic	**0.3227**	0.4007
Log age	0.3221	0.3992
Linear + square root	0.3223	**0.4011**

Table 4.2: Descriptive statistics

	Men	Women
Highest qualification, n(%)		
Bachelor's or higher	850 (21.5)	950 (22.9)
Associates degree	274 (6.9)	402 (9.7)
High school or GED	2187 (55.2)	2203 (53.2)
Less than high school	649 (16.4)	585 (14.1)
Median age of earning*:		
Associates degree	28	28.5
Bachelor's or higher	25	26
Qualifications and timing, n(%)		
No high school diploma	418 (11.4)	355 (9.1)
High school diploma/GED earned after 22	451 (12.3)	419 (10.8)
High school diploma/GED earned by 22	2800 (76.3)	3122 (80.1)
No associate's degree	3414 (93.1)	3453 (88.7)
Associate's degree earned after 26	134 (3.7)	256 (6.6)
Associate's degree earned before 26	120 (3.3)	184 (4.7)
No bachelor's degree	2975 (81.1)	3072 (78.9)
Bachelor's degree earned after 26	250 (6.8)	347 (8.9)
Bachelor's degree earned by 26	444 (12.1)	477 (12.2)

Percentages are unweighted; * amongst respondents still in study in 2010

Table 4.3: Multinomial logistic model, vs earning degree late (women)				
	No degree		Early degree	
	RR	95% C.I.	RR	95% C.I.
Years of parental education	0.90***	[0.86,0.95]	1.09**	[1.03,1.16]
Has children	2.20***	[1.58,3.07]	1.22	[0.83,1.79]
Never married	1.26	[0.77,2.05]	1.67	[0.94,2.96]
Previously married	0.99	[0.68,1.42]	0.91	[0.58,1.43]
AFQT score (%ile)	0.97***	[0.96,0.97]	1.02***	[1.01,1.03]
Black	0.42***	[0.29,0.61]	1.11	[0.71,1.72]
Hispanic	0.57**	[0.38,0.85]	0.59*	[0.35,0.99]
Family income (log $)	0.39***	[0.25,0.60]	1.69	[0.98,2.93]

* p<0.05, ** p<0.01, *** p<0.001

Table 4.4: Multinomial logistic model, vs earning degree late (men)				
	No degree		Early degree	
	RR	95% C.I.	RR	95% C.I.
Years of parental education	0.86***	[0.82,0.91]	1.03	[0.96,1.09]
Never married	0.7	[0.44,1.11]	0.98	[0.59,1.64]
Previously married	1.28	[0.81,2.04]	0.8	[0.46,1.41]
AFQT score (%ile)	0.96***	[0.96,0.97]	1.02***	[1.01,1.03]
Black	0.43***	[0.28,0.66]	1.18	[0.73,1.92]
Hispanic	0.7	[0.44,1.12]	0.8	[0.47,1.39]
Family income (log $)	0.28***	[0.16,0.46]	1.27	[0.72,2.24]

* p<0.05, ** p<0.01, ***
p<0.001

Table 4.5: Predictors of high school diploma attainment, FE models (women)								
	Late H.S.		Late H.S., lagged predictors		Early H.S.		Early H.S., lagged predictors	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Has children			1.12	[0.24,5.16]				
Family income (log $)	1.12	[0.94,1.33]	1.18	[0.92,1.51]	0.89	[0.65,1.21]	1.02	[0.63,1.67]
Never married	0.52	[0.18,1.50]	0.90	[0.26,3.16]	1.06	[0.52,2.18]	2.32	[0.51,10.46]
Previously married	1.41	[0.83,2.39]	1.70	[0.79,3.64]				
Unemployed	1.12	[0.68,1.84]	1.40	[0.69,2.85]	0.85	[0.51,1.40]	0.88	[0.45,1.68]
Out of labour force	0.74	[0.51,1.05]	0.95	[0.55,1.64]	0.9	[0.59,1.37]	0.75	[0.42,1.31]

* p<0.05, ** p<0.01, *** p<0.001 — All four models included linear and quadratic age terms.

Table 4.6: Predictors of high school diploma attainment, FE models (men)								
	Late H.S.		Late H.S., lagged predictors		Early H.S.		Early H.S., lagged predictors	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Family income (log $)	1.00	[0.86,1.16]	0.95	[0.83,1.09]	1.13	[0.85,1.50]	0.75	[0.48,1.18]
Never married	0.45	[0.18,1.10]	0.98	[0.53,1.78]	1.32	[0.62,2.81]	1.87	[0.24,14.85]
Previously married	0.77	[0.41,1.47]	0.99	[0.58,1.70]	2.01	[0.16,24.59]		
Unemployed	0.90	[0.54,1.51]	1.23	[0.80,1.87]	0.94	[0.63,1.41]	0.79	[0.48,1.31]
Out of labour force	0.78	[0.47,1.31]	0.99	[0.62,1.56]	0.92	[0.62,1.37]	0.85	[0.53,1.37]

* p<0.05, ** p<0.01, *** p<0.001 — All four models included linear and quadratic age terms.

Table 4.7: Predictors of degree attainment, FE models (women)

	Late degreees		Late degreees, lagged predictors		Early degrees		Early degrees, lagged predictors	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Has children	0.04**	[0.00,0.35]	0.32	[0.09,1.21]				
Family income (log $)	1.56	[0.49,4.94]	1.72*	[1.01,2.92]	0.87	[0.65,1.17]	0.99	[0.66,1.50]
Never married	0.3	[0.02,4.44]	2.14	[0.76,6.01]	0.54	[0.28,1.05]	0.75	[0.25,2.26]
Previously married	0.43	[0.10,1.83]	0.61	[0.21,1.77]				
Unemployed	1.51	[0.11,20.54]	1.06	[0.34,3.32]	1.47	[0.70,3.10]	1.47	[0.59,3.66]
Out of labour force	0.22*	[0.05,0.93]	0.92	[0.46,1.86]	0.34***	[0.21,0.56]	2.38***	[1.46,3.89]
* p<0.05, ** p<0.01, *** p<0.001	All four models included linear and quadratic age terms.							

Table 4.8: Predictors of degree attainment, FE models (men)

	Late degrees		Late degrees, lagged predictors		Early degrees		Early degrees, lagged predictors	
	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.	OR	95% C.I.
Family income (log $)	1.05	[0.72,1.53]	1.07	[0.76,1.51]	1.14	[0.87,1.49]	1.35	[0.89,2.03]
Never married	0.47	[0.10,2.15]	1.01	[0.39,2.66]	0.39*	[0.16,0.91]	0.68	[0.19,2.41]
Previously married	0.47	[0.13,1.63]	0.25*	[0.08,0.76]	0.28	[0.05,1.57]	0.04*	[0.00,0.49]
Unemployed	0.98	[0.36,2.73]	0.81	[0.29,2.31]	1.66	[0.78,3.55]	1.05	[0.50,2.21]
Out of labour force	0.34*	[0.12,0.99]	0.89	[0.44,1.79]	0.53**	[0.33,0.86]	0.87	[0.56,1.35]
* p<0.05, ** p<0.01, *** p<0.001			All four models included linear and quadratic age terms.					

Table 4.9: BMI and education timing at age 45 (women)

	Coeff.	95% C.I.
HS by 22	-0.88*	(-1.60,-0.15)
HS after 22	-0.40	(-1.36,0.56)
Associate's degree by 26	1.79**	(0.49,3.10)
Associate's degree after 26	1.92***	(0.82,3.02)
Baccalaureate degree by 26	-3.10***	(-4.00,-2.20)
Baccalaureate degree after 26	-1.96***	(-2.98,-0.95)

* p<0.05, ** p<0.01, *** p<0.001

Table 4.10: BMI and education timing at age 45 (men)

	Coeff.	95% C.I.
HS by 22	0.72**	(0.22,1.22)
HS after 22	0.44	(-0.24,1.11)
Associate's degree by 26	0.35	(-0.81,1.50)
Associate's degree after 26	1.05*	(0.12,1.97)
Baccalaureate degree by 26	-0.62	(-1.29,0.04)
Baccalaureate degree after 26	0.27	(-0.52,1.06)

* p<0.05, ** p<0.01, *** p<0.001

Table 4.11: BMI and education timing (women)				
	FE		FEIS	
	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22	-0.16	(-0.32,0.00)	-0.34***	(-0.48,-0.19)
HS after 22	0.06	(-0.24,0.36)	0.14	(-0.10,0.38)
Associate's degree by 26	0.07	(-0.30,0.44)	-0.21	(-0.52,0.09)
Associate's degree after 26	0.37*	(0.03,0.71)	0.23	(-0.08,0.54)
Baccalaureate degree by 26	-0.60***	(-0.85,-0.35)	-0.25*	(-0.47,-0.03)
Baccalaureate degree after 26	0.12	(-0.19,0.44)	0.59**	(0.22,0.95)
Age (years)	0.56***	(0.53,0.60)		
Age squared	-0.00***	(-0.01,-0.00)		
	FE, h.s. grads		FEIS, h.s. grads	
	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22				
HS after 22				
Associate's degree by 26	-0.02	(-0.39,0.35)	-0.30	(-0.64,0.03)
Associate's degree after 26	0.28	(-0.05,0.61)	0.17	(-0.14,0.48)
Baccalaureate degree by 26	-0.41***	(-0.65,-0.18)	-0.26*	(-0.51,-0.02)
Baccalaureate degree after 26	0.15	(-0.16,0.46)	0.54**	(0.17,0.92)
Age (years)	0.56***	(0.52,0.60)		
Age squared	-0.00***	(-0.01,-0.00)		

* p<0.05, ** p<0.01, *** p<0.001

Table 4.12: BMI and education timing (men)								
	FE		FEIS		FE, h.s. grads		FEIS, h.s. grads	
	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22	0.22***	(0.10,0.35)	0.06	(-0.05,0.17)				
HS after 22	0.20	(-0.01,0.42)	0.03	(-0.16,0.21)				
Associate's degree by 26	0.05	(-0.32,0.42)	0.17	(-0.07,0.40)	0.07	(-0.28,0.42)	0.15	(-0.09,0.39)
Associate's degree after 26	0.01	(-0.33,0.34)	-0.03	(-0.28,0.22)	0.05	(-0.29,0.39)	-0.06	(-0.32,0.19)
Baccalaureate degree by 26	-0.62***	(-0.80,-0.45)	-0.05	(-0.22,0.12)	-0.46***	(-0.63,-0.29)	-0.07	(-0.25,0.11)
Baccalaureate degree after 26	-0.10	(-0.33,0.13)	-0.14	(-0.32,0.05)	-0.06	(-0.28,0.17)	-0.14	(-0.33,0.06)
Age (years)	0.55***	(0.52,0.57)			0.51***	(0.48,0.54)		
Age squared	-0.00***	(-0.01,-0.00)			-0.00***	(-0.00,-0.00)		

* p<0.05, ** p<0.01, *** p<0.001

Table 4.13: BMI and education timing, adjusted (women)								
	FE		FEIS		FE, h.s. grads		FEIS, h.s. grads	
	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22	-0.09	(-0.32,0.14)	-0.16	(-0.41,0.09)				
HS after 22	0.27	(-0.11,0.66)	0.09	(-0.33,0.51)				
Associate's degree by 26	0.18	(-0.27,0.64)	-0.13	(-0.62,0.36)	0.10	(-0.35,0.55)	-0.25	(-0.79,0.30)
Associate's degree after 26	0.38*	(0.00,0.77)	0.54*	(0.00,1.07)	0.36	(-0.02,0.75)	0.51*	(0.01,1.02)
Baccalaureate degree by 26	-0.66***	(-0.96,-0.37)	-0.23	(-0.54,0.07)	-0.56***	(-0.84,-0.28)	-0.26	(-0.60,0.07)
Baccalaureate degree after 26	-0.08	(-0.46,0.30)	0.71***	(0.32,1.11)	-0.05	(-0.44,0.33)	0.71***	(0.31,1.10)
Age (years)	0.59***	(0.53,0.64)			0.62***	(0.56,0.67)		
Age squared	-0.00***	(-0.01,-0.00)			-0.01***	(-0.01,-0.00)		
Has children	-0.06	(-0.23,0.12)	0.11	(-0.08,0.29)	-0.15	(-0.34,0.04)	0.06	(-0.14,0.26)
Family income (log $)	0.00	(-0.07,0.06)	-0.01	(-0.07,0.05)	-0.03	(-0.11,0.05)	-0.02	(-0.10,0.07)
Never married	-0.36***	(-0.53,-0.18)	-0.55***	(-0.74,-0.36)	-0.34***	(-0.53,-0.16)	-0.58***	(-0.78,-0.37)
Previously married	-0.48***	(-0.63,-0.33)	-0.54***	(-0.70,-0.38)	-0.52***	(-0.68,-0.36)	-0.60***	(-0.77,-0.43)
Unemployed	-0.12	(-0.27,0.03)	0.06	(-0.07,0.19)	-0.08	(-0.25,0.09)	0.09	(-0.06,0.25)
Out of labour force	0.28***	(0.16,0.39)	0.39***	(0.28,0.49)	0.28***	(0.15,0.40)	0.43***	(0.30,0.55)

* p<0.05, ** p<0.01, *** p<0.001

Table 4.14: BMI and education timing, adjusted (men)

	FE		FEIS	
	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22	0.18**	(0.05,0.31)	0.08	(-0.05,0.21)
HS after 22	0.21	(-0.03,0.45)	-0.08	(-0.31,0.16)
Associate's degree by 26	0.06	(-0.30,0.42)	0.23	(-0.03,0.49)
Associate's degree after 26	-0.13	(-0.42,0.16)	-0.07	(-0.34,0.19)
Baccalaureate degree by 26	-0.59***	(-0.76,-0.42)	-0.01	(-0.19,0.17)
Baccalaureate degree after 26	-0.21	(-0.43,0.00)	-0.09	(-0.33,0.14)
Family income (log $)	-0.05	(-0.11,0.01)	-0.06	(-0.15,0.03)
Never married	-0.31***	(-0.40,-0.21)	-0.30***	(-0.39,-0.21)
Previously married	-0.42***	(-0.52,-0.31)	-0.41***	(-0.51,-0.31)
Unemployed	-0.01	(-0.10,0.08)	-0.01	(-0.09,0.07)
Out of labour force	0.08	(-0.03,0.19)	0.05	(-0.04,0.14)
Age (years)	0.53***	(0.49,0.56)		
Age squared	-0.00***	(-0.01,-0.00)		

* p<0.05, ** p<0.01, *** p<0.001

Table 4.14 cont.				
	FE, h.s. grads		FEIS, h.s. grads	
	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22				
HS after 22				
Associate's degree by 26	0.12	(-0.22,0.47)	0.27	(-0.01,0.55)
Associate's degree after 26	-0.07	(-0.36,0.22)	-0.09	(-0.37,0.20)
Baccalaureate degree by 26	-0.46***	(-0.62,-0.30)	-0.01	(-0.21,0.18)
Baccalaureate degree after 26	-0.14	(-0.35,0.07)	-0.13	(-0.37,0.12)
Family income (log $)	-0.06	(-0.16,0.03)	-0.06	(-0.21,0.09)
Never married	-0.26***	(-0.37,-0.16)	-0.32***	(-0.41,-0.22)
Previously married	-0.40***	(-0.51,-0.29)	-0.44***	(-0.55,-0.33)
Unemployed	-0.05	(-0.17,0.06)	0.00	(-0.10,0.10)
Out of labour force	0.06	(-0.07,0.19)	-0.03	(-0.15,0.09)
Age (years)	0.47***	(0.44,0.51)		
Age squared	-0.00***	(-0.00,-0.00)		

* p<0.05, ** p<0.01, *** p<0.001

Chapter 5: Does higher education affect everyone the same way?

INTRODUCTION

Education's putative role as a determinant of health suggests that it may be a mechanism through which early-life disadvantage can be overcome. For economic outcomes, education may be viewed as a vehicle of social mobility; in this context, it may instead be a vehicle of health mobility. The problem with this scenario is it is not clear that the relationship between education and health is causal. With regard to BMI, the second chapter of this dissertation showed that only a small proportion of the association between education and BMI at mid-life is plausibly causal. This is consistent with other studies which have also found that using study designs that are not subject to certain types of bias removes much of the association between educational attainment and BMI or obesity. Instead, there is evidence that BMI in childhood or adolescence is a determinant of educational attainment (Karnehed, Rasmussen, Hemmingsson, & Tynelius, 2006; von Hippel & Lynch, 2014) and that early life socio-economic conditions determine both BMI (Parsons, Powers, Logan, & Summerbell, 1999; Power et al., 2005) and educational attainment (Kodde & Ritzen, 1988).

However, studies that have not found a causal relationship between education and BMI, including the study in chapter 2 of this dissertation, may be biased towards finding null results by assuming homogeneity in the effect of education (Xie, 2011). In assuming homogeneity, any true effect that occurs in only a sub-sample will be averaged across the whole sample resulting in a smaller overall effect that is more difficult to detect. In this chapter I examine the effect of earning a bachelor's degree on BMI while allowing this effect to be heterogeneous in the sample. I focus on bachelor's degrees because other levels of education are either not a topic of discussion in terms of what proportion of the population should receive the qualification in the case of high school diplomas, relatively uncommon in the case of associate's degrees, or are overly selective for these purposes in the cases of graduate and professional degrees.

The dimension in which the effects of a bachelor's degree may vary is in childhood SES. Two competing theories predict how the effect of education could differ by SES. The first is a compensatory mechanism, whereby those who were initially disadvantaged benefit the most from education (refs). Those who come from advantaged backgrounds may already be "maximising" their health and health behaviour – or maintaining a healthy body weight – so that there is little room for improvement in these areas. In contrast, those from less advantaged backgrounds are further from the "maximum" health permitted by their own genetic and environmental factors. A related theory has been dubbed "resource substitution" by Ross and Mirowsky (2010, 2011). Resource substitution suggests that those who are relatively advantaged – whether by gender, race/ethnicity, socio-economic background, or any other factor – have more resources to draw upon in maximising their health and so any one health resource is less important, while those without these advantages must rely more heavily on education.

The second theory predicts the opposite; any benefit of earning a degree is more likely to accrue in those from more advantaged backgrounds. A cumulative advantage perspective suggests that the benefits of advantage in one domain are additive with advantages in other domains (Ben-Shlomo & Kuh, 2002; Ferraro & Shippee, 2009). Those from more advantaged backgrounds are likely to be better prepared for tertiary education and thus better able to excel academically and take advantage of the opportunities to build social capital afforded by tertiary education (Walpole, 2003). In addition, those from more advantaged backgrounds are likely to attend education institutions that are more elite or selective than their less advantaged peers (Bastedo & Jaquette, 2011; Karabel & Astin, 1975). This may mean a difference in the education received and the graduate's subsequent placement in the social hierarchy.

To my knowledge, no previous study has examined the heterogeneous effects of education on BMI. But there is a literature examining these heterogeneous effects for other health outcomes. In a sample of representative of American households in the late 1990s one study found that the association of education with self-rated health occurred mostly in those whose parents were less educated (Ross & Mirowsky, 2011). However, these results may have been influenced by the fact that educational attainment is not a random selection process.

Other studies have attempted to overcome these selection biases by introducing matching into studies of the heterogeneous effects of education. Xie, Brand and colleagues extended Rosenbaum and Rubin's work on propensity scores (1983) to divide samples into groups who would be expected to have similar likelihoods of gaining a degree and then testing for differences between those with and without degrees within these subgroups (Brand & Xie, 2010; Xie, Brand, & Jann, 2012) and several studies have followed this technique. In a study of fertility, women from less advantaged backgrounds were found to reduce the number of children after gaining a college degree by more than women from advantaged backgrounds (Brand & Davis, 2011; Xie et al., 2012). Similarly, cardiovascular disease and mortality were reduced in those with degrees from less advantaged backgrounds but not in those from more advantaged backgrounds (Schafer, Wilkinson, & Ferraro, 2013). In contrast, better self-rated health among young adults in the Add Health study was found in those with degrees from advantaged backgrounds compared to those from similar backgrounds without a degree but no similar difference was found in groups from less advantage backgrounds (Bauldry, 2014).

Although the use of matching methods makes some progress towards addressing the issue of selection effects if the assumptions associated with matching techniques hold, these works still rely on cross-sectional associations between education and BMI. Even if individuals within each subgroup are equally likely to attain a degree conditional on the variables used to identify subgroups, this does not establish the temporal sequencing of educational attainment and body weight. In the education-health and especially the education-BMI literature, there are studies which attempt to isolate causal effects from confounding and selection effects, and studies as described above which attempt to relax the homogeneity assumption. No study, however, has undertaken both. I fill this gap by using Xie and colleagues' multilevel matching techniques cross-sectionally as the studies described above have done, and then performing longitudinal analyses within the subgroups identified in the cross-sectional analysis.

METHODS

Measures

As described in chapter 2, the dependent variable is body mass index (BMI). The independent variable is education and the present study considers the effect of earning at least a bachelor's degree, indicated with a binary variable coded 1 if the respondent reported a bachelor's, graduate, or professional degree and 0 otherwise.

Analyses were adjusted for the log of family income, binary indicators of marital status, and binary indicators of employment status. In cross-sectional analyses binary indicators of 23 occupational categories based on the coding associated with the 2000 census were included.

From 1994 data were collected only in alternate years. Indexing the data by age therefore resulted in some respondents having data for odd-numbered years of age and others for even-numbered years of age. Cross-sectional measures are those reported at age 44 or 45.

PROPENSITY SCORES

The following measures were used to generate propensity scores for the probability of gaining a bachelor's degree by age 45:

Parental education – The NLSY79 records maternal and paternal education measured in years ranging from 0 to 20. Four hundred and forty-five respondents were missing education information for both parents. Of the remainder, the majority (10,517) had maternal and paternal education information; 363 had information only on paternal education, and 1,361 had information only on maternal education. For those with both measures I used the higher of the two, while I used the available measure for those with only maternal or paternal education. This has the advantage of minimising missing data, which in this case would create a bias by reducing the representation of those raised in single-family homes in the data.

Parental Income – The log of family income in 1979.

Parental employment – Respondents were asked at baseline whether their each of their parents had worked outside the home when they were age 14.

Academic aptitude – In 1979 the sample took the Armed Services Vocational Battery, and from this were given a score on the Armed Forces Qualification Test. Percentile results were renormed in 2006 to account for the youth of many of the test takers in the sample and make results comparable with other cohorts. This revised percentile score is included in the propensity score.

Race/ethnicity – NLSY79 characterises respondents as either black, Hispanic, or non-black non-Hispanic.

Friend's aspirations – Number of years of school participants thought their closest friend intended to complete, reported in 1979.

Children – All respondents were asked if they had any children in the baseline interview, and subsequent interviews asked whether they had had any (further) children since the previous interview. A binary variable was coded as 1 if women answered this question affirmatively during interviews in which they were aged 25 or younger and 0 otherwise. Having children was not incorporated into propensity scores for men.

With the exception of childbearing history for women, all variables contributing to my propensity scores have appeared in previously published studies employing similar methods on subsets of this data, including work introducing propensity scores as a tool for the analysis of heterogeneous treatment effects (Brand & Xie, 2010).

Analytic strategy

CROSS-SECTIONAL ANALYSIS

The basic cross sectional model is similar to that in Chapter Two:

$$BMI=\beta_0+\beta_1 bachelor's\ degree+\varepsilon \quad (1)$$

This model was specified with and without adjustment for marital status, (logged) family income, employment status, and occupation. As established in chapter two, there are likely to be selection effects in this cross-sectional model. This model also fails to identify the possibility of heterogeneous effects of education by childhood/adolescent (dis)advantage.

I follow recent studies (Bauldry, 2014; Brand & Davis, 2011; Schafer et al., 2013) of the heterogeneous effects of education on health in using a multilevel approach to analyse the data cross-sectionally. Propensity scores for the probability of earning a bachelor's degree by age 45 stratify the sample. Within-strata estimates of the treatment effect were obtained, and these became independent variables in a second model regressing strata number on the previously generated coefficient estimates.

The model is thus:

$$\text{Level 1:} \quad BMI_{ij}=\alpha_j+\delta_j bachelor's\ degree_{ij}+\varepsilon_{ij}$$
$$\text{Level 2:} \quad \delta_j=\delta_0+\gamma stratum+\upsilon_j \quad (2)$$

BMI is predicted by whether individual *i* has a bachelor's degree, with the effect of the bachelor's degree dependent on the stratum, *j*, to which individual *i* belongs. Again, unadjusted and adjusted versions of this model were built, with the control variables (marital status, employment status, income, occupation) introduced to the level one model and allowed to vary by strata.

Xie, Brand, and Benn have made a Stata module for this analysis publicly available.[3] In this study, propensity scores were based on a probit model predicting bachelor's

[3] Available from https://ideas.repec.org/c/boc/bocode/s457129.html

degree attainment by age 45. The sample was then stratified by propensity score so that within each strata the mean of the propensity score and of each variable contributing to it is the same for those who did and did not earn bachelor's degrees. Although the user may specify a minimum number of strata to be created, the HTE module determines the number of strata and identifies cut points such that each stratum is balanced.

LONGITUDINAL ANALYSIS

The fixed effects and fixed effects with individual slopes models employed in previous chapters were also used in the present study:

$$BMI_{ij}=\beta_0+ \beta_1 bachelor's_{ij} +\beta_2\ age_{ij} +\beta_3\ age\text{-}squared_{ij} +u_i+\varepsilon_{ij} \tag{3}$$

$$BMI_{ij}= \beta_0+ \beta_1 bachelor's_{ij} +\beta_2\ age_{ij} +\beta_3\ age\text{-}squared_{ij} + u_{1i}+ u_{2i}*age + u_{3i}*age\ squared+ \varepsilon_{ij} \tag{4}$$

To identify heterogeneous treatment effects, models were run independently in each propensity score stratum. In addition, these models were rerun including time-varying binary variables for marriage, unemployment, being out of the labour force, having any children (women only) and a continuous variable for the log of family income.

RESULTS

Propensity score generation and matching

The region of common support for men included propensity scores between 0.003 and 0.934 and for women between 0.003 and 0.908 for women. Eight strata were created for men and nine for women. Strata with small numbers of either treated or untreated cases were combined with adjacent strata (Xie et al., 2012) so that both men and women were divided into six strata. For the most advantaged women's stratum this affected the balance of the matching variables somewhat. Appendix 5.3 displays the cut points for each stratum. Characteristics of each strata are displayed in tables 5.1 and 5.2. As expected, the proportion who gained bachelor's degrees was lowest in strata one and highest in strata six for both sexes.

Stratifying may result in treatment observations close to strata cut points that are more similar to controls in adjacent strata than to those in their own. Graphical display of treatment effects over a continuous propensity score are displayed in figures 5.1 and 5.2. The figures are based on radius matching within a 0.01 calliper and common support imposed by limiting treatment observations to those with propensity scores within the range of propensity scores for controls. For men, the middle of the propensity score distribution seem to benefit from education whereas neither high nor low scores appeared to benefit. For women, treatment effect increased with increasing propensity scores, and was significantly different from 0 for propensity scores above about 0.3.

Stratification multilevel modelling

Tables 5.3 and 5.4 present the results of within-strata regressions. Significant reductions in predicted BMI for those with bachelor's degrees were observed in strata 3 and 6 for women, and stratum 5 for men. After adjusting for a range of socio-economic variables, men's strata 1 and 2 also show a difference between those with and without bachelor's degrees. The slopes relating strata to the regression coefficients appears negative for men and women but are not statistically different from 0, however with only six data points the lack of a statistically significant relationship between strata and treatment effect is not surprising. Figures 5.3 and 5.4 display graphically the results of the within-strata regressions as well as the trend line. The figures highlight that the estimates of strata-specific effects are more precise for men than for women.

Longitudinal models

Tables 5.5 and 5.6 show the change in BMI associated with gaining a bachelor's degree assuming homogeneous effects. For women, the fixed effects models without individual slopes suggest gaining a degree leads to lower BMI under the homogeneous effects assumption. Regular fixed effects models assuming homogeneous education effects predict that men who earn bachelor's degrees will experience a reduction in BMI. This was also the case in the third stratum when no time-varying covariates were included in the model, and in the third-fifth strata with the inclusion of time varying effects. Adding individual slopes to the model fully attenuated any effect of education under the homogeneous effects assumption.

Tables 5.7-5.14 show strata-specific effects. As table 5.7 shows, under the regular fixed effects model, there is no benefit of a bachelor's degree for men in any stratum, and, with the exception of strata 3, table 5.8 shows this is unchanged with the addition of time-varying covariates. Tables 5.9 and 5.10 show the same pattern when the parallel trends assumption is relaxed; that is, in no stratum is there a significant effect of earning a bachelor's degree on BMI.

Tables 5.11 and 5.12 show the strata-specific effects for women of earning a bachelor's degree when using a regular fixed effects model. A statistically significant effect is observed in stratum 3. Tables 5.13 and 5.14 show the results of FEIS models for women. In no stratum does earning a bachelor's degree lead to lower BMI.

DISCUSSION

In cross sectional analysis, it does seem that those who benefit from gaining a degree are individuals in the higher strata, i.e. those with the highest propensity towards college completion. However, some ambiguity is introduced by the fact that it was the second highest men's stratum where educated individuals experienced a benefit in terms of BMI, and the effect was also observed in a middle stratum for women. Adjusting the models for income, occupation, marital status, and employment status did not appreciably change the results for women. For men, however, relationships between earning a bachelor's degree and BMI emerged in the two lower strata with effects pointing in opposite directions.

One factor that might be influencing these results is multiple hypothesis testing. By stratifying the sample and repeating the analysis with a long list of covariates, the probability of making a type I error is increased. There are two reasons to believe that this is not the explanation for the significant findings in stratum 5 for men and stratum 6 for women. Firstly, these estimates were significant at the stricter 1% level (p=0.005 for women in stratum six in the unadjusted model and p=0.0021 in the adjusted; p=0.002 for men in stratum five in the unadjusted model and p=0.004 adjusted). One could argue that testing 6 strata for each sex, twice, with twenty five covariates requires resetting alpha to 0.05/68=0.0007. However, previous research has adjusted alpha only for the number of models rather than the number of right hand side variables in the models. Following this practice results in an adjusted threshold of 0.05/24=0.0021, by which criteria the effect detected in the high women's stratum was significant in the adjusted model and in the unadjusted model for the high men's stratum. Xie et al (2012) provide a rule of thumb that alpha should be reduced to 0.001 to account for multiple hypothesis testing, and under this criteria there was no stratum in which the effect of having a degree was significant.

There is some sentiment in epidemiological literature that the practice of applying more stringent p-values to account for multiple hypothesis testing is flawed (Perneger, 1998). This debate is far beyond the scope of this work, but one recommendation to emerge is that p-values should be interpreted in concert with the substance of results and their reproducibility. This leads to the second reason for not dismissing the results in the higher strata as being an artefact of multiple hypothesis testing. The effect of education on BMI in these strata were not sensitive to the addition and combination of covariates. The coefficients and confidence intervals changed only modestly. In contrast, the emergence of results significant at the 5% level in strata 1 and 2 for men after adjusting for potential confounding represents quite a departure from the findings in the unadjusted model, making spurious findings resulting from multiple hypothesis testing seem more likely. However, the effect observed in women's stratum 3 changes little between the unadjusted and adjusted model. Applying the same logic and concluding this is not due to random chance makes this finding difficult to explain in the context of theoretical frameworks predicting that either the most advantaged or the least advantaged will benefit from gaining a degree.

Cautiously concluding that only amongst those more likely to gain a degree does earning a degree predict lower BMI at midlife, these results are consistent with some previous findings while departing from others. Previous results have been in conflict over whether education provides health benefits to those who have advantaged or disadvantaged backgrounds. However, no previous studies have considered heterogeneous health effects of education upon body weight, other health outcomes have been studied using similar techniques. The finding that it is the most advantaged strata who benefit from education is consistent with the work of Bauldry and colleagues (2014) who found the same in their study of self-rated health, but at odds with Shafer and colleagues (2013) who found that education was most beneficial for cardiovascular health and mortality for those who were less likely to attain that education. A study also using the NLSY79 data found that the fertility-reducing effect of earning a degree was strongest in the strata least expected to earn a degree (Xie et al., 2012).

The major barrier to a causal interpretation of the cross-sectional results is the assumption that selection into treatment is strictly on the basis of the observed variables. There is a reason some earn a degree and others do not, even when each has the same propensity to do so on the basis of observed characteristics. If these reasons are correlated with BMI, or if the selection effects observed in Chapter 2 whereby women who are overweight or obese are less likely to gain baccalaureate degrees, then the cross sectional estimates are not likely to represent a true causal effect. The present study overcomes this limitation by assessing heterogeneous effects longitudinally.

For comparison purposes, results assuming homogeneous affects are presented. The variables contributing to propensity score are time invariant and so they are not included in the model. Fixed effects models suggest that both men and women can expect a modest (0.25-0.46 kg/m^2) reduction in BMI after earning bachelor's degrees, but this effect disappears when individual slopes are included in the model.

For women, fixed effects models assuming parallel trends are consistent with the cross-sectional results: earning a degree precedes a reduction in BMI in strata 3 and 6. Men in strata 3 experienced a reduction in BMI after earning a degree, and when covariates were included this was also the case in strata 4 and 5. When the parallel trends assumption was relaxed by including individual slopes in the model, there was no effect of earning a degree in any women's stratum. Before control variables were included there was a significant effect of gaining a bachelor's degree in the lowest men's stratum, but this effect disappeared after including covariates.

The FEIS models are considered the best models because they allow for individual heterogeneity in both the intercept and slope of BMI trajectory, compared to the FE models without individual slopes which only allow for individual heterogeneity in the intercept. Only in a single men's stratum was an effect of education detected in the FEIS models. Although this occurred in the lowest stratum and is therefore consistent with compensatory levelling or resource substitution, this effect was sensitive to the addition of covariates and not consistent with any other models. Therefore, this single significant finding seems more likely to be due to chance than to be a meaningful effect. On the whole, it does not seem that gaining a bachelor's degree leads to any effect on BMI at any level of propensity to gain a degree.

Limitations

This study has important strengths relative to previous research, namely in relaxing both the homogeneous effects assumption that exists in most research and in looking at the possibility of heterogeneous effects longitudinally using fixed effects models with individual slopes. However, some limitations remain.

The first relates to the possibility of type I and type II errors. As discussed above, stratifying the analyses means that a greater number of hypotheses are tested and thus the probability of an effect being observed due to random chance increases. In other words, the probability of making type one errors is increased. Because no significant and meaningful differences were detected in the FEIS models – FEIS models being the strongest models presented in terms of their utility for making causal inferences – it does not seem that type I error is a problem here. However, stratifying the sample also means fewer individuals are included in each analysis, reducing the power of the study to detect a true difference and thus increasing the probability of making a type II error. Lack of power could explain the lack of significant findings detected in the FEIS models, although there were some significant findings in the models of fixed effects without individual slopes. It is not clear how including individual slopes in a fixed effects model would affect statistical power; the sample size and pre-determined alpha would remain unchanged while the standard errors associated with parameter estimates appear to increase by between 5% and 50% for these analyses.

The propensity score generating variables are problematic in two ways. Firstly, these variables were all based on interviews conducted in 1979, but many asked about circumstances when the respondent was 14 years old. For younger respondents this would have been the present or recent past, but older members of the sample would have needed to recall their circumstances up to eight years prior, possibly introducing recall bias. Secondly, the propensity scores were generated cross-sectionally based on whether respondents had earned a degree or not at age 44 or 45. Using these propensity scores and the strata based on them in longitudinal analysis implies that the propensity to gain a degree does not change as the sample ages, which may not be a tenable assumption. Future research may consider generating longitudinal propensity scores using a Cox model including time-varying predictors as well as early life circumstances.

An important issue that could not be addressed in this study is the possibility of heterogeneity of degree granting institutions. Students from advantaged backgrounds are not only more likely to gain a degree at all, but are also more likely to attend more prestigious universities and colleges (Oseguera & Astin, 2004). It is likely that I n the lower strata, the analyses test the effect of an education at non-elite institutions while in the higher strata the effect being tested is that of gaining a degree from an elite institution.

It should also be noted that in combining strata to ensure a minimum number of treated and untreated in each, the resulting highest propensity stratum for women had significant differences between the treated and untreated in some of the matching variables, and it was in this stratum that a treatment effect was detected cross-sectionally.

In chapter 2 it was established that a large portion of the association between BMI and education can be explained by selection into education with overweight and obese young women likely to terminate their education earlier than their normal-weight peers. By the same logic that suggests the effects of education may not be uniform, it may be the case that selection effects interact with early life socio-economic circumstances. Future research is warranted into whether the strata-specific associations of education and BMI represent strata-specific selection effects.

Conclusions

These findings largely contradict the hypothesis that the reason no plausibly causal effect of education was detected in chapter 2 of this dissertation, or in the results presented in tables 5.5 and 5.6 of this chapter, is that true effects occurring in a subset of the sample were diluted when averaged across the whole sample. Instead, it seems more likely that attaining a bachelor's degree does not lead to lower body weight.

The lack of heterogeneous effects allows some inferences to be drawn about the relative importance of one's earlier experience. Gaining a bachelor's degree does not lead to a change in BMI. This means that those from similar backgrounds remain alike in their BMI trajectories even after some receive bachelor's degrees. Education therefore, at least at the baccalaureate level, cannot be a means of ameliorating the BMI consequences of early life circumstances.

REFERENCES

Bastedo, M. N., & Jaquette, O. (2011). Running in Place: Low-Income Students and the Dynamics of Higher Education Stratification. *Educational Evaluation and Policy Analysis*, *33*(3), 318–339. http://doi.org/10.3102/0162373711406718

Bauldry, S. (2014). Conditional health-related benefits of higher education: An assessment of compensatory versus accumulative mechanisms. *Social Science & Medicine*, *111*, 94–100. http://doi.org/10.1016/j.socscimed.2014.04.005

Ben-Shlomo, Y., & Kuh, D. (2002). A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *International Journal of Epidemiology*, *31*(2), 285–293. http://doi.org/10.1093/ije/31.2.285

Brand, J. E., & Davis, D. (2011). The Impact of College Education on Fertility: Evidence for Heterogeneous Effects. *Demography*, *48*(3), 863–887. http://doi.org/10.1007/s13524-011-0034-3

Brand, J. E., & Xie, Y. (2010). Who Benefits Most from College? Evidence for Negative Selection in Heterogeneous Economic Returns to Higher Education. *American Sociological Review*, *75*(2), 273–302. http://doi.org/10.1177/0003122410363567

Ferraro, K. F., & Shippee, T. P. (2009). Aging and Cumulative Inequality: How Does Inequality Get Under the Skin? *The Gerontologist*, *49*(3), 333–343. http://doi.org/10.1093/geront/gnp034

Karabel, J., & Astin, A. W. (1975). Social Class, Academic Ability, and College "Quality." *Social Forces*, *53*(3), 381–398. http://doi.org/10.1093/sf/53.3.381

Karnehed, N., Rasmussen, F., Hemmingsson, T., & Tynelius, P. (2006). Obesity and Attained Education: Cohort Study of More Than 700,000 Swedish Men. *Obesity*, *14*(8), 1421–1428. http://doi.org/10.1038/oby.2006.161

Kodde, D. A., & Ritzen, J. M. M. (1988). Direct and Indirect Effects of Parental Education Level on the Demand for Higher Education. *The Journal of Human Resources*, *23*(3), 356–371. http://doi.org/10.2307/145834

Oseguera, L., & Astin, A. W. (2004). The Declining "Equity" of American Higher Education. *The Review of Higher Education*, *27*(3), 321–341. http://doi.org/10.1353/rhe.2004.0001

Parsons, T. j., Powers, C., Logan, S., & Summerbell, C. d. (1999). Childhood predictors of adult obesity: a systematic review. *International Journal of Obesity & Related Metabolic Disorders*, *23*, S1–S107.

Perneger, T. V. (1998). What's Wrong with Bonferroni Adjustments. *BMJ: British Medical Journal*, *316*(7139), 1236–1238.

Power, C., Graham, H., Due, P., Hallqvist, J., Joung, I., Kuh, D., & Lynch, J. (2005). The contribution of childhood and adult socioeconomic position to adult obesity and smoking behaviour: an international comparison. *International Journal of Epidemiology*, *34*(2), 335–344. http://doi.org/10.1093/ije/dyh394

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41–55. http://doi.org/10.1093/biomet/70.1.41

Ross, C. E., & Mirowsky, J. (2010). Gender and the Health Benefits of Education. *Sociological Quarterly*, *51*(1), 1–19. http://doi.org/10.1111/j.1533-8525.2009.01164.x

Ross, C. E., & Mirowsky, J. (2011). The interaction of personal and parental education on health. *Social Science & Medicine*, *72*(4), 591–599. http://doi.org/10.1016/j.socscimed.2010.11.028

Schafer, M. H., Wilkinson, L. R., & Ferraro, K. F. (2013). Childhood (Mis)fortune, Educational Attainment, and Adult Health: Contingent Benefits of a College Degree? *Social Forces*, *91*(3), 1007–1034. http://doi.org/10.1093/sf/sos192

Von Hippel, P. T., & Lynch, J. L. (2014). Why are educated adults slim—Causation or selection? *Social Science & Medicine*, *105*, 131–139. http://doi.org/10.1016/j.socscimed.2014.01.004

Walpole, M. (2003). Socioeconomic Status and College: How SES Affects College Experiences and Outcomes. *The Review of Higher Education*, *27*(1), 45–73. http://doi.org/10.1353/rhe.2003.0044

Xie, Y. (2011). Causal inferenece and heterogeneity bias in social science. *Information, Knowledge, Systems Management*, *10*(1), 279–289. http://doi.org/10.3233/IKS-2012-0197

Xie, Y., Brand, J. E., & Jann, B. (2012). Estimating Heterogeneous Treatment Effects with Observational Data. *Sociological Methodology*, *42*(1), 314–347. http://doi.org/10.1177/0081175012452652

Table 5.1: Strata balance (women)

Matching variable, mean difference (95% C.I.)

Strata	Parental education (years)		AFQT percentile		Hispanic		Black		Kids by 25	
1	0.49	(-0.21,1.19)	4.21	(-0.33,8.74)	0	(-0.10,0.11)	0.06	(-0.05,0.18)	-0.01	(-0.14,0.11)
2	-0.77*	(-1.39,-0.16)	-1.62	(-6.97,3.73)	0.09	(-0.00,0.18)	0.11	(-0.01,0.22)	-0.02	(-0.15,0.11)
3	-0.26	(-0.86,0.34)	0.14	(-4.64,4.91)	0.02	(-0.06,0.10)	-0.07	(-0.17,0.03)	-0.07	(-0.18,0.04)
4	-0.05	(-0.61,0.51)	-1.62	(-6.09,2.84)	-0.05	(-0.13,0.03)	0.01	(-0.08,0.11)	-0.04	(-0.13,0.04)
5	0.38	(-0.09,0.85)	1.45	(-1.36,4.25)	0.01	(-0.04,0.07)	-0.05	(-0.12,0.01)	-0.03	(-0.07,0.02)
6	0.79**	(0.22,1.37)	4.55***	(2.04,7.05)	-0.10**	(-0.16,-0.04)	-0.03	(-0.11,0.05)	-0.02	(-0.05,0.00)

Strata	Parental income 1979 (log $)		Mother worked		Father worked		Friend's expected years of school	
1	-0.07	(-0.19,0.05)	0.09	(-0.04,0.22)	0.02	(-0.06,0.10)	0.45	(-0.03,0.93)
2	0.02	(-0.08,0.12)	-0.02	(-0.15,0.11)	-0.07	(-0.14,0.00)	0.35	(-0.19,0.88)
3	-0.02	(-0.13,0.10)	0.01	(-0.12,0.15)	0.05	(-0.01,0.11)	-0.07	(-0.57,0.43)
4	0.04	(-0.06,0.13)	-0.05	(-0.18,0.08)	-0.04	(-0.10,0.02)	0.21	(-0.30,0.71)
5	0.02	(-0.07,0.10)	0.01	(-0.09,0.11)	0.01	(-0.03,0.05)	-0.21	(-0.51,0.10)
6	0.16**	(0.06,0.26)	-0.02	(-0.14,0.09)	0.04	(-0.00,0.08)	-0.03	(-0.26,0.20)

* p<0.05, ** p<0.01, *** p<0.001

Table 5.2: Strata balance (men)

Strata	Matching variable, mean difference (95% C.I.) Parental education (years)		AFQT percentile		Hispanic		Black	
1	0.03	(-0.61,0.67)	7.59***	(3.55,11.63)	0.08	(-0.01,0.17)	0.00	(-0.11,0.12)
2	-0.01	(-0.65,0.63)	-0.52	(-4.47,3.43)	0.00	(-0.09,0.09)	0.02	(-0.08,0.13)
3	0.16	(-0.53,0.86)	-0.90	(-4.49,2.69)	-0.08	(-0.17,0.01)	0.05	(-0.05,0.14)
4	-0.11	(-0.80,0.58)	2.00	(-1.36,5.37)	-0.03	(-0.11,0.05)	0.00	(-0.08,0.09)
5	0.19	(-0.31,0.68)	1.52	(-0.54,3.58)	-0.02	(-0.07,0.04)	-0.05	(-0.11,0.00)
6	0.34	(-0.31,0.99)	2.21*	(0.33,4.08)	0.00	(-0.07,0.06)	-0.06	(-0.13,0.02)
Strata	Parental income 1979 (log $)		Mother worked		Father worked		Friend's expected years of school	
1	-0.08	(-0.19,0.03)	-0.03	(-0.15,0.10)	0.03	(-0.05,0.10)	0.43	(-0.04,0.91)
2	0.02	(-0.10,0.15)	0.09	(-0.05,0.22)	-0.05	(-0.11,0.02)	0.18	(-0.37,0.73)
3	0.05	(-0.04,0.14)	-0.06	(-0.19,0.08)	0.02	(-0.03,0.07)	0.06	(-0.46,0.59)
4	-0.01	(-0.13,0.10)	-0.07	(-0.21,0.07)	0.04	(-0.01,0.09)	-0.13	(-0.65,0.39)
5	0.06	(-0.02,0.14)	-0.02	(-0.12,0.08)	-0.01	(-0.05,0.03)	-0.01	(-0.28,0.26)
6	0.02	(-0.12,0.15)	0.07	(-0.06,0.19)	0.00	(-0.04,0.04)	-0.05	(-0.30,0.21)

* p<0.05, ** p<0.01, *** p<0.001

Table 5.3: Treatment effect by strata and trend (men)				
TE by strata	Coef.	95% C.I.	Coef.‡	95% C.I.
(Lowest propensity scores) 1	1.37	(-0.36, 3.10)	2.44*	(0.43, 4.44)
2	-1.06	(-2.47, 0.36)	-1.72*	(-3.42, -0.01)
3	-0.30	(-1.71, 1.12)	0.14	(-1.62, 1.90)
4	-1.19	(-2.98, 0.60)	-1.53	(-4.07, 1.01)
5	-1.92**	(-3.14, -0.69)	-2.33**	(-3.90, -0.75)
(Highest propensity scores) 6	0.37	(-1.33, 2.09)	1.29	(-0.73, 3.30)
Linear trend				
slope	-0.28	(-0.66, 0.10)	-0.28	(-0.73, 0.17)

* p<0.05, ** p<0.01, *** p<0.001

‡ Controlled for marital status, occupation, income, and employment status

Table 5.4: Treatment effect by strata and trend line (women)				
TE by strata	Coef.	95% C.I.	Coef.‡	95% C.I.
(Lowest propensity scores) 1	-0.24	(-2.21, 1.74)	-1.10	(-3.50, 1.31)
2	0.06	(-2.15, 2.26)	0.99	(-1.51, 3.49)
3	-2.20*	(-4.07, -0.35	-2.57*	(-5.08,-0.06)
4	0.33	(-1.70, 2.37)	0.49	(-2.26, 3.25)
5	-1.07	(-2.73, 0.59)	-1.63	(-3.67, 0.41)
(Highest propensity scores) 6	-2.41**	(-4.11, 0.73)	-2.35*	(-4.35, -0.35)
Linear trend				
slope	-0.34	(-0.78, 0.10)	-0.35	(-0.87, 0.19)

* p<0.05, ** p<0.01, *** p<0.001

‡ Controlled for marital status, occupation, income, and employment status

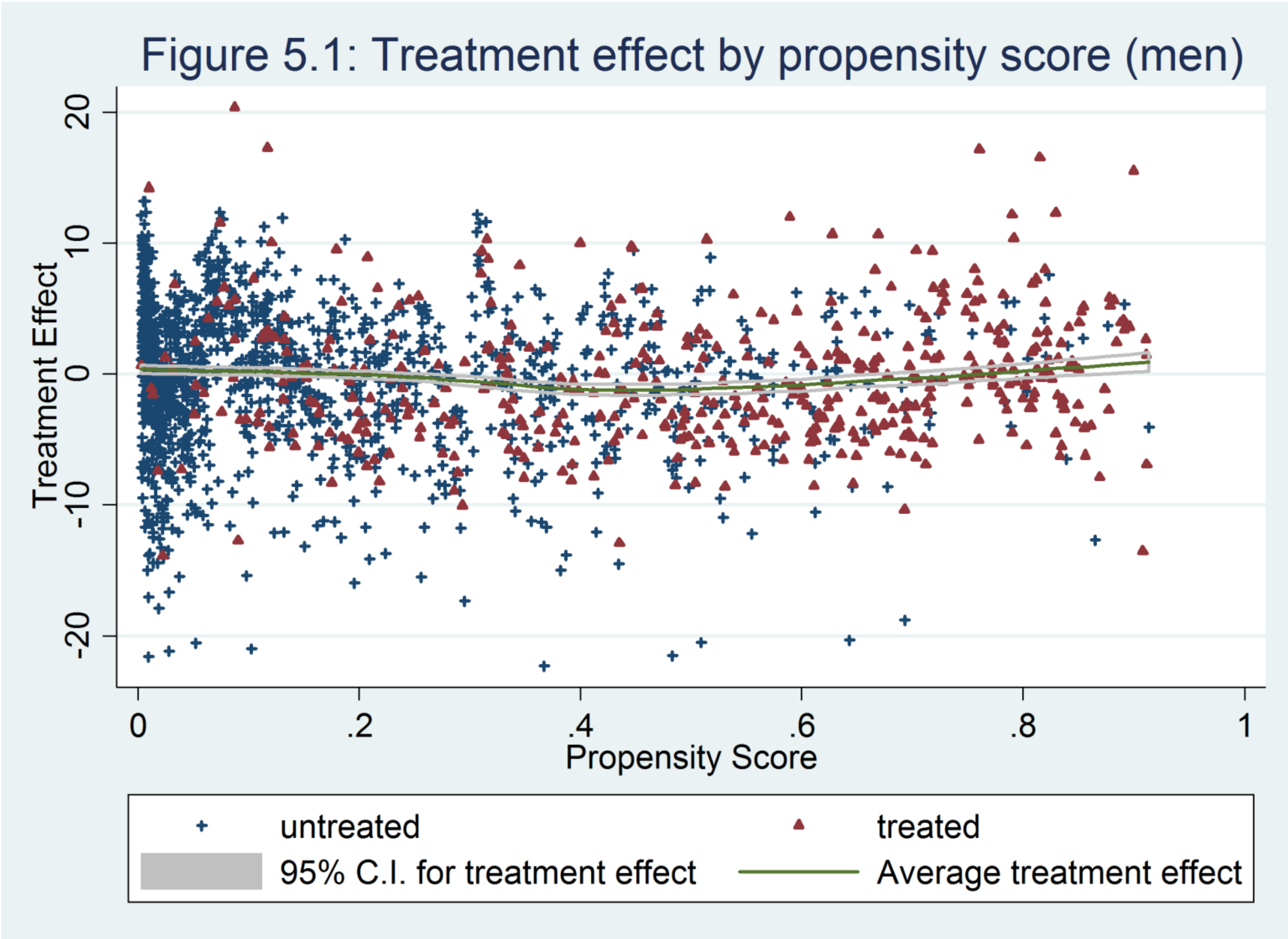
Figure 5.1: Treatment effect by propensity score (men)
Treatment Effect
20
10
0
-10
-20
0
.2
.4
.6
.8
1
Propensity Score
untreated
treated
95% C.I. for treatment effect
Average treatment effect

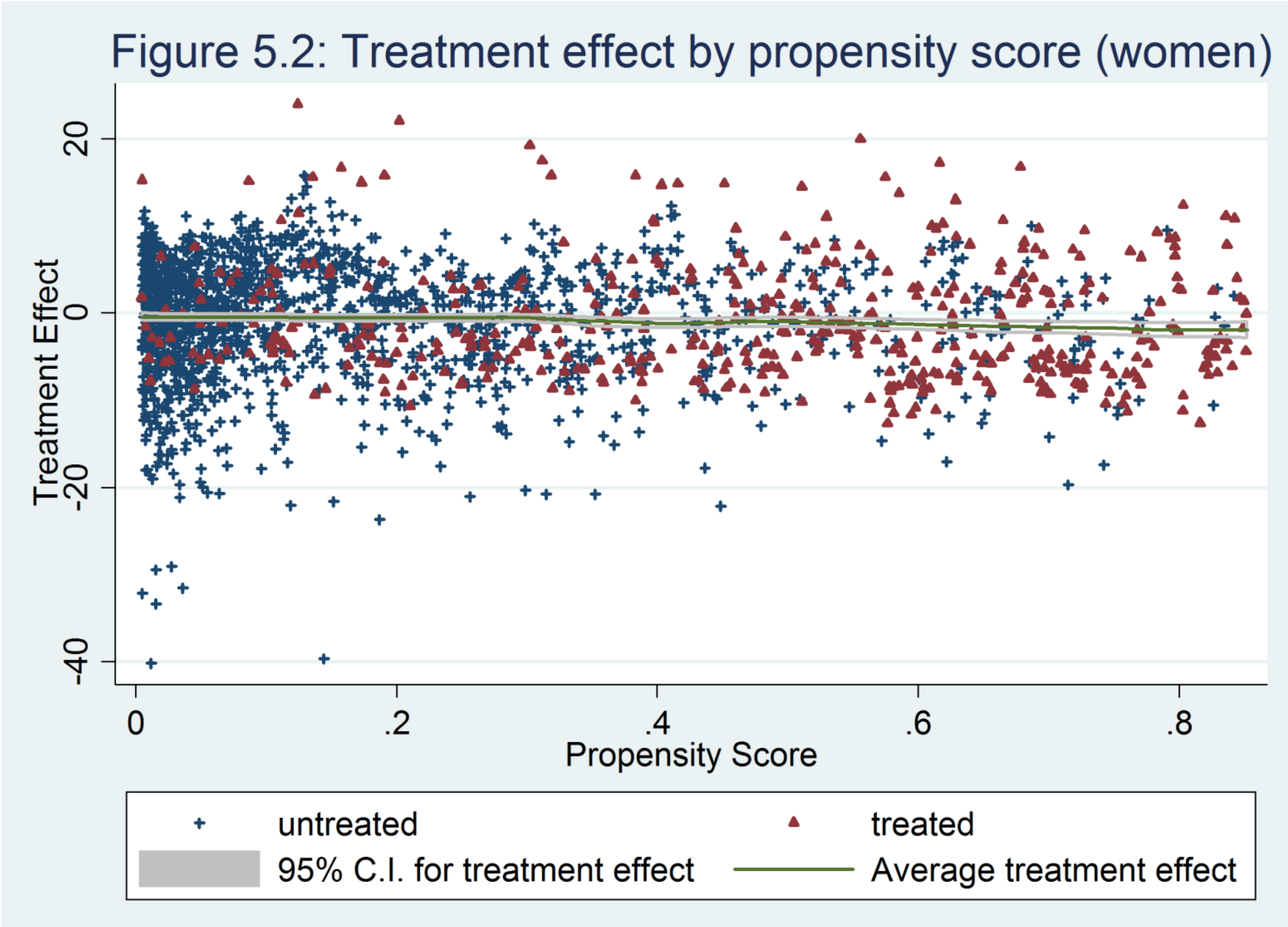

Figure 5.2: Treatment effect by propensity score (women)
Treatment Effect
20
0
-20
-40
0
.2
.4
.6
.8
Propensity Score
untreated
treated
95% C.I. for treatment effect
Average treatment effect

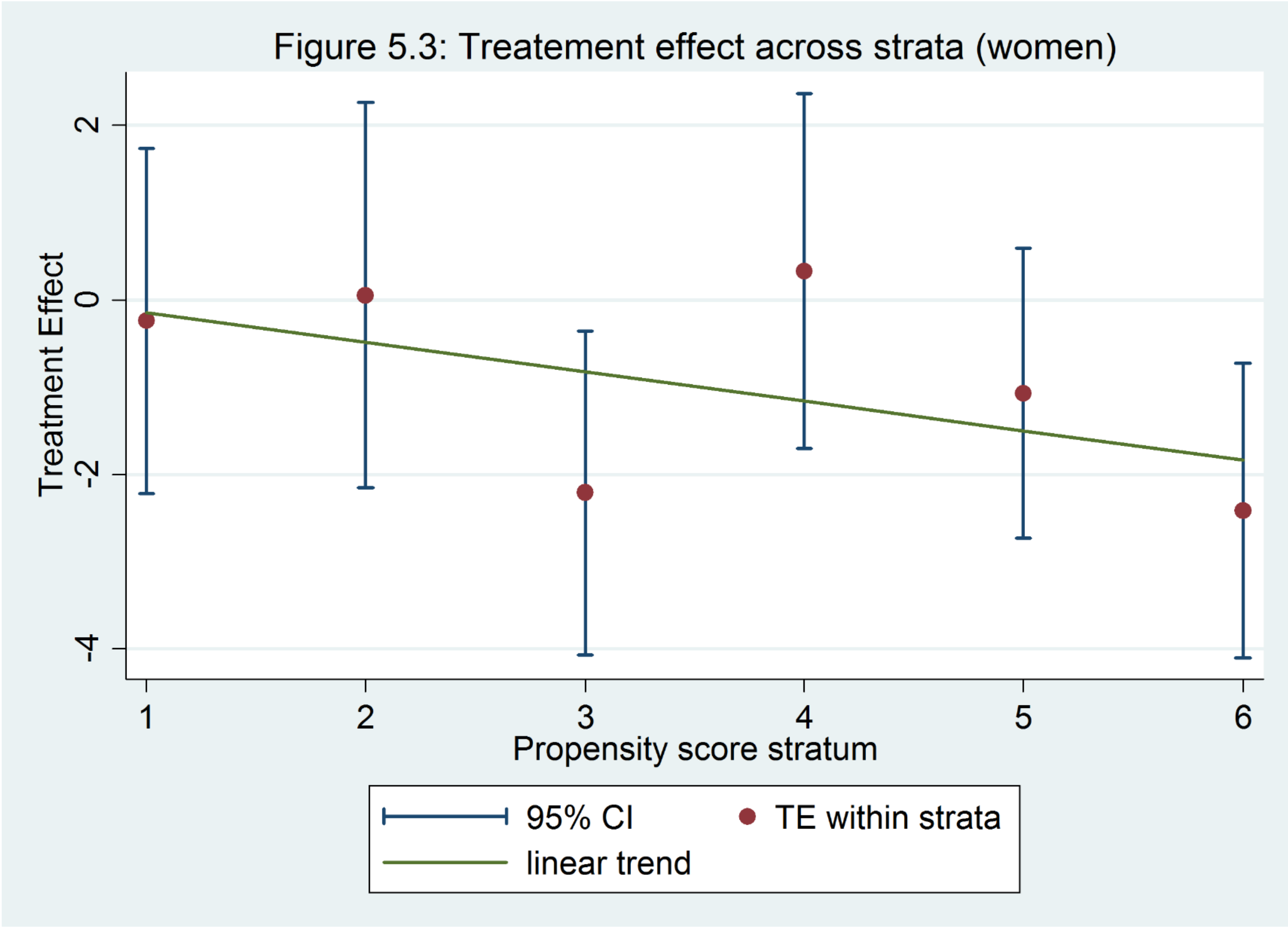

Figure 5.3: Treatement effect across strata (women)
Treatment Effect
2
0
-2
-4
1
2
3
4
5
6
Propensity score stratum
95% CI
TE within strata
linear trend

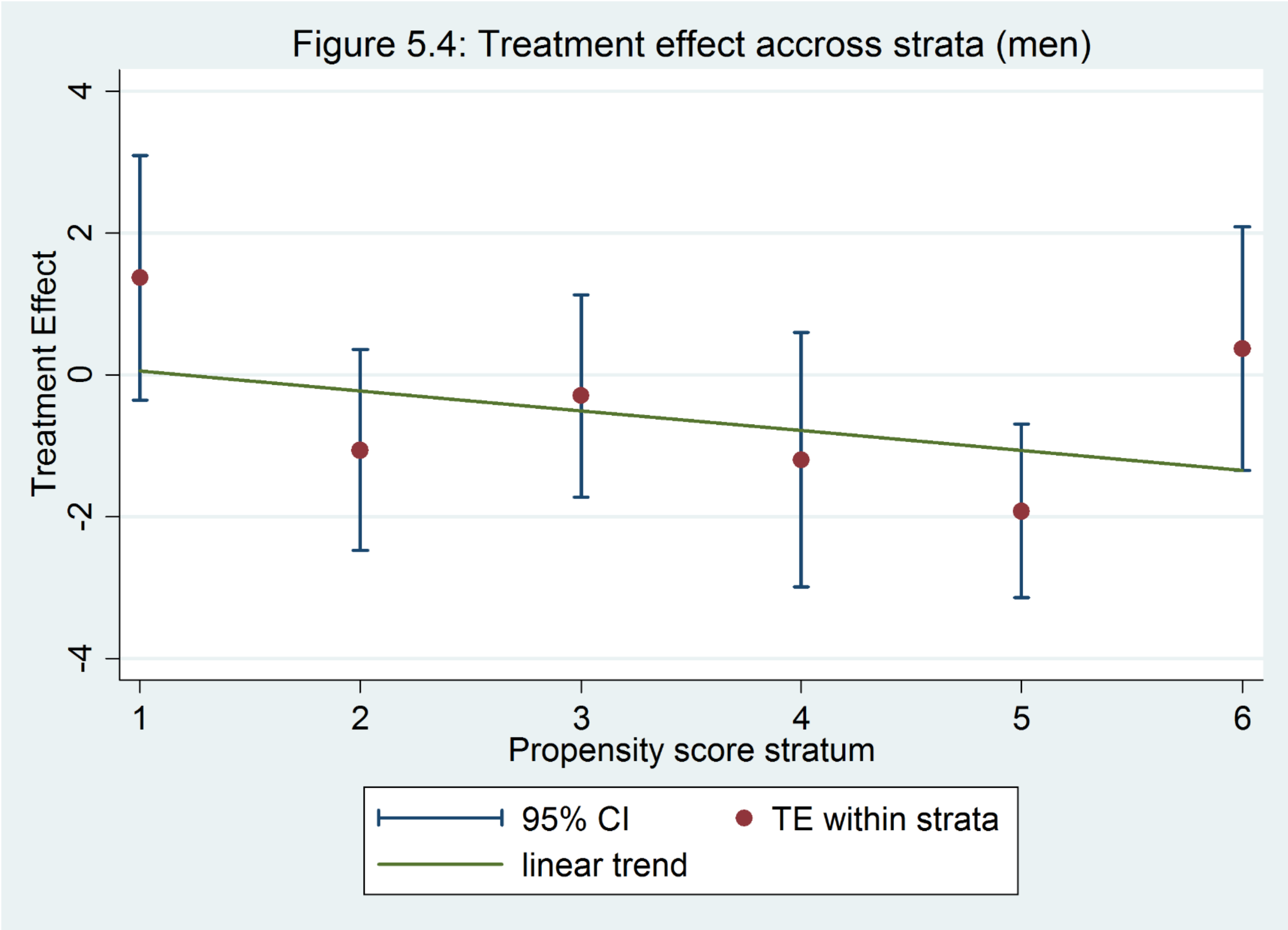

Figure 5.4: Treatment effect accross strata (men)
Treatment Effect
4
2
0
-2
-4
1
2
3
4
5
6
Propensity score stratum
95% CI
TE within strata
linear trend

Table 5.5: Bachelor's degrees and BMI, assuming homogeneous effects (women)								
	FE		FE with covariates		FEIS		FEIS with covariates	
	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.
Bachelor's degree	-0.25*	(-0.45,-0.04)	-0.41***	(-0.65,-0.18)	0.12	(-0.08,0.32)	0.12	(-0.12,0.36)
Age (years)	0.55***	(0.52,0.58)	0.58***	(0.53,0.62)				
Age squared	-0.00***	(-0.00,-0.00)	-0.00***	(-0.01,-0.00)				
Has children			-0.10	(-0.27,0.08)			0.11	(-0.07,0.29)
Income (log $)			0.00	(-0.06,0.06)			-0.01	(-0.07,0.06)
Married			0.42***	(0.30,0.54)			0.54***	(0.42,0.66)
Unemployed			-0.12	(-0.26,0.03)			0.06	(-0.07,0.19)
Out of labour force			0.28***	(0.17,0.40)			0.39***	(0.28,0.50)

* p<0.05, ** p<0.01, *** p<0.001

Table 5.6: Bachelor's degrees and BMI, assuming homogeneous effects (men)								
	FE		FE with covariates		FEIS		FEIS with covariates	
	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.
Bachelor's degree	-0.40***	(-0.55,-0.26)	-0.46***	(-0.60,-0.33)	-0.09	(-0.21,0.04)	-0.05	(-0.19,0.09)
Age (years)	0.56***	(0.54,0.59)	0.54***	(0.50,0.57)				
Age squared	-0.01***	(-0.01,-0.00)	-0.00***	(-0.01,-0.00)				
Income (log $)			-0.05	(-0.11,0.01)			-0.06	(-0.15,0.03)
Married			0.35***	(0.28,0.42)			0.35***	(0.28,0.41)
Unemployed			-0.02	(-0.11,0.07)			-0.01	(-0.09,0.07)
Out of labour force			0.07	(-0.04,0.18)			0.05	(-0.04,0.14)

* p<0.05, ** p<0.01, *** p<0.001

Table 5.7: Strata-specific effects of bachelor's degrees (men), FE model						
	Strata 1		Strata 2		Strata 3	
Bachelor's degree	0.17	[-0.53,0.86]	-0.40	[-0.86,0.06]	-0.36	[-0.89,0.16]
Age (years)	0.56***	[0.51,0.61]	0.53***	[0.44,0.62]	0.47***	[0.38,0.56]
Age squared	-0.01***	[-0.01,-0.00]	-0.00***	[-0.01,-0.00]	-0.00***	[-0.01,-0.00]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	-0.20	[-0.73,0.33]	-0.20	[-0.58,0.19]	0.14	[-0.15,0.43]
Age (years)	0.41***	[0.31,0.52]	0.43***	[0.34,0.52]	0.43***	[0.35,0.52]
Age squared	-0.00***	[-0.00,-0.00]	-0.00***	[-0.00,-0.00]	-0.00***	[-0.00,-0.00]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.8: Strata-specific effects of bachelor's degrees (men), FE model with covariates

	Strata 1		Strata 2		Strata 3	
Bachelor's degree	-0.08	[-0.74,0.58]	-0.28	[-0.73,0.17]	-0.51*	[-0.97,-0.05]
Age (years)	0.51***	[0.44,0.57]	0.57***	[0.46,0.68]	0.41***	[0.30,0.52]
Age squared	-0.00***	[-0.01,-0.00]	-0.01***	[-0.01,-0.00]	-0.00***	[-0.00,-0.00]
Net family income (log $)	0.03	[-0.05,0.10]	-0.19	[-0.43,0.04]	0.11	[-0.07,0.28]
Never married	-0.52***	[-0.74,-0.30]	-0.23	[-0.55,0.09]	-0.61***	[-0.97,-0.25]
Previously married	-0.43***	[-0.62,-0.24]	-0.66***	[-1.02,-0.30]	-0.34	[-0.71,0.03]
Unemployed	0.02	[-0.14,0.18]	-0.08	[-0.42,0.26]	0.10	[-0.32,0.52]
Out of labour force	-0.03	[-0.27,0.20]	0.20	[-0.33,0.74]	0.00	[-0.38,0.38]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	-0.27	[-0.71,0.17]	-0.30	[-0.65,0.04]	0.12	[-0.14,0.38]
Age (years)	0.33***	[0.20,0.46]	0.50***	[0.38,0.61]	0.46***	[0.36,0.57]
Age squared	0.00	[-0.00,0.00]	-0.00***	[-0.01,-0.00]	-0.00***	[-0.01,-0.00]
Net family income (log $)	-0.23*	[-0.46,-0.00]	-0.10	[-0.26,0.05]	-0.03	[-0.19,0.13]
Never married	-0.24	[-0.61,0.13]	0.02	[-0.30,0.35]	0.05	[-0.24,0.33]
Previously married	-1.11***	[-1.55,-0.67]	-0.53**	[-0.94,-0.13]	-0.44	[-1.17,0.29]
Unemployed	-0.20	[-0.62,0.22]	0.09	[-0.37,0.54]	0.19	[-0.17,0.55]
Out of labour force	0.08	[-0.32,0.48]	0.24	[-0.04,0.53]	0.03	[-0.30,0.36]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.9: Strata-specific effects of bachelor's degrees (men), FEIS model

	Strata 1		Strata 2		Strata 3	
Bachelor's degree	-0.49*	[-0.92,-0.05]	-0.24	[-0.64,0.15]	-0.22	[-0.71,0.26]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	0.17	[-0.17,0.52]	-0.07	[-0.33,0.18]	-0.07	[-0.27,0.12]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.10: Strata-specific effects of bachelor's degrees (men), FEIS model with covariates

	Strata 1		Strata 2		Strata 3	
Bachelor's degree	-0.12	[-0.72,0.47]	-0.14	[-0.53,0.25]	-0.34	[-0.84,0.16]
Net family income (log $)	-0.03	[-0.12,0.06]	-0.16*	[-0.31,-0.01]	0.11	[-0.04,0.25]
Never married	-0.36***	[-0.56,-0.16]	-0.13	[-0.40,0.14]	-0.49**	[-0.82,-0.15]
Previously married	-0.43***	[-0.60,-0.25]	-0.54***	[-0.85,-0.23]	-0.34*	[-0.68,-0.01]
Unemployed	0.01	[-0.13,0.14]	-0.06	[-0.40,0.29]	0.12	[-0.17,0.41]
Out of labour force	0.1	[-0.11,0.31]	-0.07	[-0.51,0.38]	0.06	[-0.29,0.41]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	0.06	[-0.30,0.42]	-0.12	[-0.40,0.16]	-0.01	[-0.20,0.19]
Net family income (log $)	0	[-0.18,0.18]	0.05	[-0.04,0.15]	0.02	[-0.10,0.14]
Never married	-0.55***	[-0.87,-0.23]	-0.23	[-0.50,0.05]	-0.15	[-0.36,0.05]
Previously married	-0.76**	[-1.22,-0.30]	-0.49***	[-0.77,-0.21]	-0.45	[-0.94,0.03]
Unemployed	0.08	[-0.26,0.42]	0.22	[-0.16,0.60]	0.30*	[0.03,0.57]
Out of labour force	-0.2	[-0.51,0.10]	-0.03	[-0.29,0.24]	-0.08	[-0.28,0.12]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.11 Strata-specific effects of bachelor's degrees (women), FE model

	Strata 1		Strata 2		Strata 3	
Bachelor's degree	0.39	[-0.30,1.09]	0.56	[-0.38,1.49]	-0.93**	[-1.59,-0.26]
Age (years)	0.55***	[0.49,0.61]	0.60***	[0.48,0.71]	0.42***	[0.30,0.55]
Age squared	-0.00***	[-0.01,-0.00]	-0.01***	[-0.01,-0.00]	-0.00**	[-0.00,-0.00]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	-0.09	[-0.75,0.57]	-0.16	[-0.62,0.30]	-0.36	[-0.86,0.14]
Age (years)	0.48***	[0.35,0.60]	0.48***	[0.36,0.59]	0.58***	[0.43,0.74]
Age squared	-0.00***	[-0.01,-0.00]	-0.00***	[-0.01,-0.00]	-0.01***	[-0.01,-0.00]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.12: Strata-specific effects of bachelor's degrees (women), FE model with covariates						
	Strata 1		Strata 2		Strata 3	
Bachelor's degree	0.11	[-0.80,1.02]	0.3	[-0.72,1.33]	-0.88*	[-1.66,-0.10]
Age (years)	0.56***	[0.47,0.66]	0.54***	[0.38,0.70]	0.46***	[0.30,0.63]
Age squared	-0.00***	[-0.01,-0.00]	-0.00***	[-0.01,-0.00]	-0.00**	[-0.01,-0.00]
Net family income (log $)	0.01	[-0.12,0.14]	0.24*	[0.01,0.47]	0.03	[-0.20,0.26]
Never married	-0.75***	[-1.12,-0.38]	-1.03***	[-1.63,-0.42]	-0.22	[-0.73,0.30]
Previously married	-0.59***	[-0.87,-0.30]	-0.36	[-0.85,0.13]	-0.43	[-1.02,0.17]
Unemployed	-0.18	[-0.45,0.09]	0.12	[-0.34,0.57]	0.45	[-0.23,1.13]
Out of labour force	0.31**	[0.08,0.53]	0.34	[-0.11,0.78]	0.43*	[0.06,0.81]
Has children	-0.42*	[-0.79,-0.05]	0.03	[-0.55,0.62]	-0.12	[-0.67,0.44]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	-0.43	[-1.24,0.39]	-0.16	[-0.75,0.43]	-0.37	[-0.90,0.15]
Age (years)	0.59***	[0.40,0.79]	0.55***	[0.37,0.73]	0.65***	[0.44,0.87]
Age squared	-0.01***	[-0.01,-0.00]	-0.00***	[-0.01,-0.00]	-0.01***	[-0.01,-0.00]
Net family income (log $)	-0.23	[-0.52,0.05]	-0.14	[-0.38,0.10]	-0.31*	[-0.56,-0.06]
Never married	-0.26	[-0.88,0.36]	-0.17	[-0.66,0.32]	0.09	[-0.57,0.76]
Previously married	-0.73*	[-1.32,-0.14]	-0.86**	[-1.41,-0.31]	-0.37	[-1.13,0.39]
Unemployed	-0.17	[-1.03,0.69]	-0.64*	[-1.28,-0.00]	-0.02	[-0.56,0.51]
Out of labour force	0.37	[-0.17,0.90]	0.08	[-0.34,0.51]	-0.05	[-0.48,0.38]
Has children	-0.14	[-0.83,0.55]	0.17	[-0.40,0.73]	0.11	[-0.47,0.70]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.13: Strata-specific effects of bachelor's degrees (women), FEIS model						
	Strata 1		Strata 2		Strata 3	
Bachelor's degree	0.35	[-0.23,0.94]	0.5	[-0.47,1.47]	0.28	[-0.17,0.73]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	-0.07	[-0.82,0.67]	0.13	[-0.19,0.45]	0.03	[-0.63,0.70]

* p<0.05, ** p<0.01, *** p<0.001

Table 5.14: Strata-specific effects of bachelor's degrees (women), FEIS model with covariates						
	Strata 1		Strata 2		Strata 3	
Bachelor's degree	-0.1	[-1.00,0.80]	0.66	[-0.50,1.83]	0.26	[-0.53,1.05]
Net family income (log $)	-0.03	[-0.16,0.10]	0.24	[-0.10,0.57]	0.02	[-0.19,0.22]
Never married	-0.69**	[-1.12,-0.27]	-0.49	[-1.12,0.13]	-0.56	[-1.15,0.03]
Previously married	-0.63***	[-0.90,-0.36]	-0.67*	[-1.24,-0.10]	-0.88**	[-1.41,-0.34]
Unemployed	-0.06	[-0.31,0.19]	0.73**	[0.26,1.20]	0.75*	[0.15,1.35]
Out of labour force	0.28*	[0.06,0.50]	0.74*	[0.18,1.30]	0.56**	[0.17,0.94]
Has children	0.1	[-0.28,0.47]	-0.12	[-0.82,0.58]	0.17	[-0.46,0.81]
	Strata 4		Strata 5		Strata 6	
Bachelor's degree	-0.12	[-1.00,0.76]	0.11	[-0.53,0.75]	0.24	[-0.16,0.64]
Net family income (log $)	-0.29*	[-0.51,-0.07]	0.1	[-0.05,0.26]	-0.23*	[-0.45,-0.00]
Never married	-0.74*	[-1.34,-0.13]	-0.4	[-1.07,0.26]	-0.51*	[-0.95,-0.08]
Previously married	-0.98***	[-1.55,-0.41]	-0.90**	[-1.44,-0.36]	-1.13**	[-1.82,-0.44]
Unemployed	-0.22	[-0.90,0.46]	-0.07	[-0.54,0.40]	-0.49	[-1.03,0.05]
Out of labour force	0.63**	[0.19,1.06]	0.38*	[0.03,0.72]	0.01	[-0.30,0.31]
Has children	-0.04	[-0.77,0.70]	0.26	[-0.30,0.82]	0.41	[-0.11,0.92]

* p<0.05, ** p<0.01, *** p<0.001

Chapter 6: Conclusion

This dissertation was motivated by two questions. Is education a potentially useful policy tool to improve population health outcomes? Can the health consequences of earlier disadvantage be ameliorated by subsequent improvements in socio-economic circumstances? To answer these questions I explored the effects of education on BMI using a complex random sample of the American population born between 1956 and 1964. One of the strengths of the analyses performed was the use of fixed effects models with individual slopes to generate estimates of the effects of education that were not subject to individual heterogeneity in BMI trajectories. In this chapter I summarise the findings of the three empirical studies, discuss their implications for theory and for policy making, and suggest directions for future research.

SUMMARY OF FINDINGS

To address the motivating questions, the three studies in this dissertation were designed to answer the following research questions:

- Is there a selection effect linking BMI to educational attainment?
- To what degree is the frequently observed association between education and BMI plausibly a causal relationship?
- Is the potentially causal relationship between education and BMI affected by the age at which education was completed?
- Do the effects of education on BMI differ by childhood/adolescent socioeconomic status?

Chapter 2 demonstrated that women's, but not men's, BMI or body weight status at age 17 is highly predictive of their educational attainment by age 45. This association may be due to confounding by an unmeasured variable, but was robust to maternal education, number of siblings, percentile score on an aptitude test, race/ethnicity, and whether the respondent had any children. These results are not sufficient to establish a causal relationship between BMI and education, but certainly suggest that the relationship in middle age between education and BMI is at least partially explained by either differential selection or education and BMI sharing a common cause.

Very little of the observed association between educational attainment and BMI in the mid-40s can be attributed to a causal relationship between education and BMI. The cross-sectional relationship is largely attenuated with the addition of covariates. A much smaller effect size persists in fixed effects models, implying that gaining these qualifications precedes a reduction in BMI. However, when individual slopes are incorporated into the model, only women who earn high school diplomas or equivalent experience a reduction in BMI and this effect is sensitive to the addition of covariates. Using the model most robust to individual heterogeneity, therefore, suggests that there is no causal relationship between gaining educational qualifications and protection against weight gain.

There is some evidence that the timing of education in the life course matters. Women who earn bachelor's degrees on time can expect a reduction in BMI according to fixed effects models with individual slopes, holding constant income, marital status, employment status and parenthood. However the decision to return to schooling after an absence must have been prompted by something and is by definition time varying, and so it is impossible to rule out selection effects. Bachelor's degrees earned later in life do not offer even the same modest advantages in BMI as those earned on time, but this is probably attributable to the circumstances prompting later-life degree completion.

There is no evidence that the effect of education differs by socio-economic background. At midlife, those from higher socio-economic backgrounds with degrees did have lower BMIs than those from similar backgrounds without degrees. However, in longitudinal analyses earning a baccalaureate did not precede a reduction (or a slowing of growth) in BMI, leading to the conclusion that earning a bachelor's degree is not protective against weight gain no matter one's socio-economic background. The effect of education – or lack thereof – is not heterogeneous.

CONTRIBUTIONS TO THEORY

In general, for this cohort, using BMI as a measure of health, there is no evidence to suggest that education is generally protective of health. It may be that women's health benefits when women earn degrees at the normative ages, although it is impossible to rule out selection effects.

If the relationship between education and BMI is not causal, what explains this relationship? Chapter two of this dissertation suggests that, at least for women, body weight at age 17 is predictive of educational attainment. While this helps rule out a causal relationship between education and BMI, it does not point to which of the alternative mechanisms – reverse causality or an unmeasured third factor – is driving the relationship. Plausible scenarios exist for both explanations. Reverse causality could operate by young women internalising the negative messages prevalent in society about the worth and abilities of people who are overweight and thus lower their academic aspirations. Equally, early life disadvantage could result in toxic stress pathways that both encourage the accumulation of body fat and impair cognitive development and thus academic performance and advancement. Both scenarios are exemplars, with other mechanisms of both reverse causality and a common third factor possible.

The finding that education did not lead to lower BMI is consistent with insights from lifecourse epidemiology. Two major theories in life course epidemiology predict that improvements in SES, for example by increasing education, particularly well into adulthood, are unlikely to improve health trajectories. Timing hypotheses which emphasise critical or sensitive periods suggest that there are developmental periods when these trajectories are plastic and outside of these periods little change is possible. Cumulative hypotheses suggest that exposures to advantage or disadvantage are cumulative and changes in exposures cannot reverse the effects of previous exposures.

These hypotheses are largely confirmed by the results of chapters three and four. Earning bachelor's degrees on time seems to offer a benefit for women, whereas degrees earned late do not and may even be associated with worsening health. Gaining an education is therefore not a uniformly health promoting accomplishment; it is effective only in early adulthood. Even if the increases in BMI following late completion of education can be attributed to selection effects with negative life circumstances prompting an increase in education, this further suggests that improving one's circumstances through education is not sufficient to overcome these circumstances. When the sample was divided into groups with similar probabilities of gaining baccalaureate qualifications – a measure that can be considered a proxy for early life disadvantage – there was no plausibly causal effect of earning the degree. Individuals' BMI trajectories were the same as those of their peers with similar backgrounds, whether or not they had earned a degree. Together, these results suggest that earlier exposures have more effect on BMI.

POLICY IMPLICATIONS

Collectively, the three studies suggest that early exposures have enduring consequences not susceptible to what is commonly thought of as the most powerful vehicle of social mobility. It appears there is a narrow window during which education may be effective in changing the BMI trajectories of women. Increasing participation in education beyond this window will have little effect on the prevalence or incidence of obesity. Moreover, education is not a panacea for disadvantages experienced earlier in life. Whatever the merits of making education, particularly tertiary education, accessible to disadvantaged groups, policies in this area are unlikely to lead to a reduction in the prevalence of obesity or greater equity in its distribution.

Instead, attention should be focussed earlier in life. This dissertation provides evidence in support of the hypothesis that at some point in the lifecourse, it becomes too late to alter BMI trajectories by improving socio-economic status through education. Policy makers at both the federal and state levels are beginning to give more attention to the role of early childhood and the potential of policy targeting this period to have social and health benefits. At the national level, President Obama's 2013 State of the Union address signalled the administration's newfound focus on early childhood and a description of the White House's priorities for early childhood is featured prominently in its online summary of the educational agenda. Early childhood education is also on state policy agendas. For example, incoming Texas Governor Abbot has prioritised pre-kindergarten education reform in the state and the state legislature recently approved new spending for this reform. Of course, it is not clear that such policies at the federal or state level will be effective in preventing obesity or equalising its distribution. This will depend on the nature of the programmes offered, and in fact it could be that the influences of school environments are unable to overcome the influences of home. Nonetheless, policy attention is at least focused on the stage of life before health trajectories become difficult to change.

Obesity-specific policy interventions should target childhood and early adolescence, focusing on individuals who are predicted to be at risk of adult obesity by their childhood socio-economic status. Importantly, this should not be limited to those children who are already overweight or obese in childhood. While childhood bodyweight may predict adult bodyweight, the health effects of childhood disadvantage may accumulate over a longer period and so may not manifest during childhood. Specific policy interventions to improve the long term body weight outcomes of children from relatively disadvantaged homes fall into two categories: those directly related to obesity and those related to disadvantage. Examples of the first would include attempts to alter the relative affordability of less nutritious versus more nutritious food, while examples of the second would include interventions in housing or education policy such that children routinely interact with peers (and adults) from a range of levels of socio-economic status.

Given the lack of effect of education on BMI, should public health advocates maintain an interest in education policy? I would argue yes. Although not tested in this dissertation, education may be a means to generate health mobility intergenerationally. One's BMI trajectory appears to be largely determined by childhood circumstances. Parental education may be one of the greatest contributors to these childhood circumstances.

Although the focus of this dissertation has been the roles of education and socio-exposures at different stages in the lifecourse in BMI trajectories, another policy issue emerges from the finding that the body weight of adolescent women predicts their educational attainment. This research was not designed to assess whether high body weight causally prevents young women's educational advancement, but the gendered nature of this phenomenon strongly suggests that the relationship is causal rather than the result of some third factor causing both high BMI and low educational attainment in women only.

To the degree that we believe being overweight or obese *causes* young women – but not young men – to terminate their education, it is necessary to seriously consider the unintended consequences of anti-obesity policy. Larger women already face discrimination, harassment, and prejudice, and the linkage of leanness with health or overweight with unhealthiness may provide a pretext for manifestations of these. The public policy interest in reducing obesity prevalence is in lowering the costs of medical care for the sequelae of obesity. Yet there is also a public benefit in promoting healthy body image and in ensuring capable young women do not prematurely limit their socio-economic opportunities. The health-promotion goals of obesity policy would be better served by a more holistic approach to health among people with high BMI that is not merely focussed on weight loss but on maintaining psychological and social health in a society that privileges slenderness.

DIRECTIONS FOR FUTURE RESEARCH

The motivating questions of this dissertation point to two research communities which can incorporate these findings and use them to inform future research: the first is those interested in the social epidemiology of obesity and the second is those interested in the relationship between socio-economic status and health across the life course. Researchers from either camp would do well to attempt to replicate these findings in other contexts. This dissertation examines the effect of education on BMI within a single U.S. cohort. While similar analyses have been undertaken on a younger U.S. cohort, more research is needed to establish whether these findings are idiosyncratic or represent more universal relationships. It will be important to attempt to replicate these findings in 1) other U.S. cohorts, 2) other high-income countries, and 3) low- and middle-income countries. Ideally, observation of the sample would begin at birth. From such research it will be possible to establish what features of the education-BMI relationship are fundamental and which are context dependent.

Future researchers of both orientations may also consider examining the effects of education that does not lead to a degree. Like the studies that make up this dissertation, research examining the effects of education is typically focussed on the formal primary, secondary, tertiary education system. But the universe of education, particularly post-secondary education – is much broader, comprising vocational training, apprenticeships, and on-the-job training in addition to academic qualifications. These types of education are likely to lead to economic gains, while it is not clear whether they would contribute to "learned effectiveness" (Mirowsky & Ross, 2003) in the same way that more academic education does.

Obesity researchers should also seek to work with data with more robust measures of adiposity than BMI. The validity of BMI is questionable due to its inability to account for body composition. Athletes, for example, are often considered obese under the usual BMI categorisations, despite having very body fat percentages. More problematic in a population based sample are racial differences in the boundaries of healthy BMI.

Researchers interested in lifecourse epidemiology and the timing of socio-economic exposures will want to expand this research in two ways. Firstly, the analyses presented in this dissertation need to be replicated on other health outcomes. There are some aspects of the relationships between education, age, and health outcomes that will be common to many measures of health while others will be condition-specific. Secondly, other measures of socio-economic status and mobility will be important, particularly given the finding here that on the whole education does not lead to lower BMI. Will other means of improving socio-economic status after adolescence be similarly ineffective?

In addition, those interested in lifecourse epidemiology may also consider examining the intergenerational effects of education on BMI. The results here point to early life circumstances as difficult to overcome in terms of BMI trajectories. Education may not alter individuals' trajectories but might determine the early life circumstances experienced by their offspring, thereby affecting the health of the next generation.

FINAL THOUGHTS

In public health, disparities are often framed in terms of counterfactuals, for example, considering the disease burden if the less educated had the same BMI as the more educated (Harper & Strumpf, 2012). This dissertation has shown that the policy lever to bring about that counterfactual is not simply increasing education. Instead, it will be necessary to determine the underlying reason that those who become highly educated are also likely to have lower BMIs than those who do not achieve the same level of education. The studies that make up this dissertation suggest the answer is to be found relatively early in life.

The motivating questions for this dissertation appear to be answered, if tentatively, in the negative. Education does not seem to be a viable policy tool to prevent weight gain, meaning a search for other tools is necessary. BMI trajectories appear to be path dependent; suggesting a new policy problem if most adults cannot reasonably expect that their health will improve with improvements in their circumstances.

REFERENCES

Harper, S., & Strumpf, E. C. (2012). Social Epidemiology: Questionable Answers and Answerable Questions. *Epidemiology*, *23*(6), 795–798. http://doi.org/10.1097/EDE.0b013e31826d078d

Mirowsky, J., & Ross, C. E. (2003). *Education, Social Status, and Health*. Hawthorne, NY: Aldine de Gruyter.

Appendices

Appendix 3.1: Selection into education (multinomial logistic model, compared to achieving high school graduation only)

	Less than HS		Associate's degree		Bachelor's degree		Graduate degree	
Men								
	RR	95% C.I.	RR	95% C.I.	RR	95% C.I.	RR	95% C.I.
Underweight	0.97	0.62, 1.51	0.91	0.45, 1.84	0.95	0.57, 1.59	1.05	0.50, 2.21
Normal weight	---ref---		---ref---		---ref---		---ref---	
Overweight	0.94	0.68, 1.30	0.93	0.61, 1.41	0.99	0.72, 1.34	0.78	0.50, 1.26
Obese	1.09	0.55, 2.18	0.85	0.30, 2.40	0.72	0.31, 1.70	0.56	0.15, 2.05
Mother's education (years)	0.91	0.88, 0.95	1.04	0.98, 1.09	1.16	1.11, 1.21	1.25	1.17, 1.33
Hispanic	0.93	0.67, 1.27	1.81	1.20, 2.74	1.27	0.91, 1.78	1.62	0.97, 2.70
Black	0.58	0.45, 0.74	1.46	0.99, 2.17	1.71	1.30, 2.26	1.87	1.19, 2.94
Aptitude test percentile	0.96	0.95, 0.97	1.02	1.01, 1.02	1.04	1.04, 1.05	1.06	1.06, 1.07
Number of siblings	1.05	1.01, 1.09	1.00	0.95, 1.07	0.94	0.90, 0.99	0.88	0.81, 0.96
Women								
	RR	95% C.I.	RR	95% C.I.	RR	95% C.I.	RR	95% C.I.
Underweight	0.89	0.60, 1.31	1.14	0.79, 1.65	1.09	0.78, 1.52	1.3	0.83, 2.04
Normal weight	---ref---		---ref----		----ref----		----ref----	
Overweight	1.34	0.97, 1.83	0.91	0.59, 1.40	0.8	0.52, 1.21	0.54	0.26, 1.13
Obese	1.90	1.03, 3.49	0.75	0.25, 2.25	0.35	0.10, 1.26	0.53	0.13, 2.25
Mother's education (years)	0.92	0.89, 0.96	1.03	0.99, 1.08	1.12	1.08, 1.17	1.18	1.12, 1.26
Hispanic	0.96	0.70, 1.27	1.61	1.13, 2.31	1.52	1.08, 2.14	2.16	1.39, 3.37
Black	0.55	0.42, 0.73	1.86	1.37, 2.53	2.73	2.09, 3.57	2.40	1.55, 3.71
Aptitude test score	0.96	0.95, 0.97	1.02	1.01, 1.03	1.05	1.04, 1.05	1.06	1.05, 1.07
Number of siblings	1.06	1.02, 1.10	1.00	0.95, 1.03	0.96	0.91, 1.00	0.92	0.87, 0.99
Ever pregnant (age 17)	2.81	1.80, 4.38	0.76	0.36, 1.57	0.26	0.08, 0.85	0.14	0, >1

Appendix 3.2: Effect of education on BMI, with age interactions (women)

	FE, age interactions		FEIS, age interactions	
	Coeff.	95% C.I.	Coeff.	95% C.I.
High school	-0.05	(-0.61,0.51)	-0.54	(-1.48,0.40)
Associates degrees	0.18	(-0.68,1.03)	-0.98	(-2.85,0.89)
Bachelor's degrees	0.71*	(0.05,1.37)	-2.01**	(-3.42,-0.60)
Graduate and professional degrees	-1.28	(-2.56,0.00)	-0.26	(-2.93,2.40)
Age (years)	0.55***	(0.50,0.60)		
Age squared	-0.00***	(-0.01,-0.00)		
Has children	-0.07	(-0.24,0.10)	0.1	(-0.09,0.28)
Net family income (log $)	0	(-0.06,0.07)	-0.01	(-0.08,0.05)
Married	0.42***	(0.30,0.54)	0.54***	(0.42,0.67)
Unemployed	-0.11	(-0.26,0.04)	0.06	(-0.08,0.19)
Out of labour force	0.29***	(0.18,0.40)	0.38***	(0.28,0.49)
H.S.age interaction	0	(-0.02,0.03)	0.02	(-0.02,0.06)
Associate's degree* age interaction	0	(-0.02,0.03)	0.04	(-0.02,0.11)
Bachelor's degree*age interaction	-0.03**	(-0.05,-0.01)	0.08**	(0.03,0.13)
Graduate or professional degree*age interaction	0.02	(-0.02,0.05)	0.01	(-0.07,0.10)

* p<0.05, ** p<0.01, *** p<0.001

Appendix 3.3: Effect of early and late education on BMI, with age interactions (men)				
	FE, age interactions		FEIS, age interactions	
	Coeff.	95% C.I.	Coeff.	95% C.I.
High school	0.23	(-0.12,0.59)	0.2	(-0.36,0.75)
Associates degrees	0.25	(-0.40,0.91)	1.00*	(0.03,1.96)
Bachelor's degrees	0.21	(-0.22,0.65)	0.31	(-0.80,1.43)
Graduate and professional degrees	1.25	(-0.57,3.07)	2.39	(-3.37,8.16)
Age (years)	0.50***	(0.47,0.54)		
Age squared	-0.00***	(-0.00,-0.00)		
Net family income (log $)	-0.04	(-0.11,0.02)	-0.06	(-0.15,0.03)
Married	0.36***	(0.29,0.44)	0.35***	(0.28,0.41)
Unemployed	-0.01	(-0.10,0.08)	-0.01	(-0.09,0.07)
Out of labour force	0.08	(-0.03,0.20)	0.06	(-0.03,0.14)
H.S.age interaction	0	(-0.02,0.01)	-0.01	(-0.03,0.02)
Associate's degree* age interaction	-0.01	(-0.03,0.01)	-0.03	(-0.07,0.00)
Bachelor's degree*age interaction	-0.02**	(-0.03,-0.01)	-0.02	(-0.06,0.03)
Graduate or professional degree*age interaction	-0.05	(-0.09,0.00)	-0.06	(-0.24,0.11)

* p<0.05, ** p<0.01, *** p<0.001

Appendix 3.4: Education and overweight/obesity (men)								
	FE		FEIS		FE, h.s. grads		FEIS, h.s. grads	
	OR	95% C.I.	Coeff.	95% C.I.	OR	95% C.I.	Coeff.	95% C.I.
High school	1.48***	[1.27,1.74]	0	[-0.02,0.02]				
Associates degrees	1.11	[0.86,1.43]	0	[-0.03,0.04]	1.05	[0.81,1.37]	0	[-0.03,0.03]
Bachelor's degrees	1.05	[0.86,1.28]	0.01	[-0.02,0.03]	1.11	[0.90,1.38]	0	[-0.02,0.03]
Graduate and professional degrees	1.08	[0.79,1.48]	-0.02	[-0.06,0.02]	1.04	[0.75,1.44]	-0.02	[-0.06,0.02]
Age (years)	2.04***	[1.98,2.11]			2.08***	[2.00,2.16]		
Age squared	0.99***	[0.99,0.99]			0.99***	[0.99,0.99]		

* p<0.05, ** p<0.01, *** p<0.001

Appendix 3.5: Education and overweight/obesity, adjusted (men)								
	FE		FEIS		FE, h.s. grads		FEIS, h.s. grads	
	OR	95% C.I.	Coeff.	95% C.I.	OR	95% C.I.	Coeff.	95% C.I.
High school	1.42***	[1.15,1.74]	-0.01	[-0.03,0.02]				
Associates degrees	1.04	[0.75,1.44]	0	[-0.04,0.04]	1	[0.71,1.40]	0	[-0.04,0.04]
Bachelor's degrees	0.86	[0.67,1.09]	0.01	[-0.01,0.04]	0.92	[0.72,1.19]	0.01	[-0.02,0.04]
Graduate and professional degrees	0.97	[0.64,1.45]	-0.01	[-0.06,0.04]	0.95	[0.63,1.44]	-0.01	[-0.06,0.05]
Age (years)	2.01***	[1.91,2.12]			2.02***	[1.90,2.15]		
Age squared	0.99***	[0.99,0.99]			0.99***	[0.99,0.99]		
Net family income (log $)	0.96	[0.91,1.01]	-0.01*	[-0.01,-0.00]	0.99	[0.92,1.06]	0	[-0.01,0.00]
Married	1.95***	[1.74,2.19]	0.05***	[0.03,0.06]	1.98***	[1.74,2.25]	0.04***	[0.03,0.06]
Unemployed	0.89	[0.76,1.04]	-0.01	[-0.02,0.00]	0.96	[0.79,1.16]	-0.01	[-0.02,0.01]
Out of labour force	1.14	[0.97,1.33]	0.02**	[0.01,0.03]	1.12	[0.91,1.37]	0.01	[-0.01,0.03]

* p<0.05, ** p<0.01, *** p<0.001

Appendix 3.6: Education and overweight/obesity (women)								
	FE		FEIS		FE, h.s. grads		FEIS, h.s. grads	
	OR	95% C.I.	Coeff.	95% C.I.	OR	95% C.I.	Coeff.	95% C.I.
High school	1.05	[0.89,1.24]	-0.01	[-0.03,0.00]				
Associates degrees	1.47***	[1.19,1.81]	0.01	[-0.01,0.04]	1.46***	[1.16,1.82]	0	[-0.03,0.03]
Bachelor's degrees	2.04***	[1.63,2.56]	0.02	[-0.00,0.04]	2.04***	[1.61,2.58]	0.01	[-0.01,0.04]
Graduate and professional degrees	2.05***	[1.47,2.85]	0.02	[-0.01,0.06]	1.90***	[1.36,2.66]	0.02	[-0.01,0.06]
Age (years)	1.76***	[1.71,1.81]			1.78***	[1.71,1.84]		
Age squared	1.00***	[0.99,1.00]			1.00***	[0.99,1.00]		

* p<0.05, ** p<0.01, *** p<0.001

Appendix 3.7: Education and overweight/obesity, adjusted (women)								
	FE		FEIS		FE, h.s. grads		FEIS, h.s. grads	
	OR	95% C.I.	Coeff.	95% C.I.	OR	95% C.I.	Coeff.	95% C.I.
High school	1.12	[0.81,1.54]	-0.03	[-0.06,0.00]				
Associates degrees	1.36	[0.94,1.95]	0.03	[-0.02,0.08]	1.36	[0.93,2.00]	0.02	[-0.03,0.07]
Bachelor's degrees	1.4	[0.94,2.07]	0	[-0.04,0.04]	1.4	[0.93,2.10]	0	[-0.04,0.04]
Graduate and professional degrees	1.93*	[1.02,3.65]	0.05	[-0.02,0.11]	1.73	[0.91,3.28]	0.05	[-0.02,0.12]
Has children	1.25	[0.99,1.56]	0.03	[-0.00,0.06]	1.13	[0.88,1.46]	0.02	[-0.02,0.05]
Net family income (log $)	1.02	[0.95,1.10]	0	[-0.01,0.01]	1.04	[0.95,1.15]	0	[-0.01,0.01]
Married	2.21***	[1.89,2.59]	0.06***	[0.04,0.08]	2.27***	[1.89,2.72]	0.07***	[0.05,0.09]
Unemployed	1.01	[0.82,1.26]	0	[-0.02,0.02]	1.24	[0.97,1.60]	0.01	[-0.01,0.04]
Out of labour force	1.41***	[1.21,1.65]	0.03***	[0.01,0.04]	1.42***	[1.19,1.70]	0.03***	[0.02,0.05]
Age (years)	1.76***	[1.65,1.87]			1.78***	[1.66,1.92]		
Age squared	0.99***	[0.99,1.00]			0.99***	[0.99,1.00]		

* p<0.05, ** p<0.01, *** p<0.001

Appendix 4.1: Effect of early and late education on BMI, with age interactions (women)								
	FE, age interactions		FEIS, age interactions		FE, age interactions		FEIS, age interactions	
	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22	-0.44*	(-0.87,-0.01)	-1.19***	(-1.88,-0.50)	-0.09	(-0.65,0.46)	-2.21	(-4.98,0.57)
HS after 22	-0.98*	(-1.84,-0.12)	0.1	(-0.89,1.09)	-0.64	(-1.92,0.64)	0.44	(-1.69,2.57)
Associate's degree by 26	0.39	(-0.37,1.14)	-0.34	(-1.67,0.98)	0.31	(-0.69,1.31)	0.56	(-3.08,4.20)
Associate's degree after 26	-0.22	(-1.21,0.77)	0.22	(-1.31,1.74)	0.24	(-1.32,1.81)	-0.29	(-3.64,3.07)
Baccalaureate degree by 26	0.40	(-0.09,0.90)	-0.62	(-1.66,0.43)	0.78*	(0.10,1.46)	-0.91	(-3.33,1.52)
Baccalaureate degree after 26	0.04	(-1.09,1.17)	0.36	(-1.66,2.39)	-0.13	(-1.49,1.23)	-1.07	(-4.02,1.87)
HS by 22 * age	0.01	(-0.01,0.03)	0.04**	(0.01,0.08)	0.00	(-0.03,0.02)	0.11	(-0.04,0.25)
HS after 22 * age	0.03*	(0.00,0.05)	0.00	(-0.03,0.03)	0.02	(-0.01,0.06)	-0.01	(-0.09,0.06)
Associate's degree by 26 *age	-0.01	(-0.04,0.01)	0.01	(-0.05,0.06)	0.00	(-0.04,0.03)	-0.03	(-0.18,0.12)
Associate's degree after 26 *age	0.01	(-0.01,0.04)	0.00	(-0.05,0.05)	0.00	(-0.04,0.04)	0.03	(-0.08,0.13)
Baccalaureate degree by 26 age	-0.03***	(-0.05,-0.01)	0.01	(-0.03,0.05)	-0.04***	(-0.07,-0.02)	0.03	(-0.07,0.12)
Baccalaureate degree after 26*age	0.00	(-0.03,0.03)	0.01	(-0.05,0.06)	0.00	(-0.04,0.04)	0.06	(-0.04,0.15)
Age (years)	0.56***	(0.53,0.60)			0.58***	(0.52,0.63)		
Age squared	-0.00***	(-0.01,-0.00)			-0.00***	(-0.01,-0.00)		
Has children					-0.01	(-0.18,0.17)	0.10	(-0.08,0.28)
Family income (log $)					0.01	(-0.06,0.07)	-0.01	(-0.08,0.05)
Never married					-0.37***	(-0.55,-0.20)	-0.55***	(-0.74,-0.36)
Previously married					-0.48***	(-0.63,-0.34)	-0.54***	(-0.70,-0.38)
Unemployed					-0.11	(-0.26,0.04)	0.06	(-0.07,0.19)
Out of labour force					0.29***	(0.17,0.40)	0.39***	(0.28,0.49)

* p<0.05, ** p<0.01, *** p<0.001

Appendix 4.2: Effect of early and late education on BMI , with age interactions (men)

	FE, age interactions		FEIS, age interactions		FE, age interactions		FEIS, age interactions	
	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.	Coeff.	95% C.I.
HS by 22	-0.06	(-0.37,0.25)	-0.24	(-0.89,0.41)	0.16	(-0.20,0.52)	0.24	(-0.83,1.32)
HS after 22	0.19	(-0.46,0.84)	-0.59	(-1.28,0.11)	0.01	(-0.75,0.77)	-0.57	(-1.83,0.68)
Associate's degree by 26	0.37	(-0.52,1.26)	0.98	(-0.07,2.04)	0.64	(-0.23,1.51)	2	(-0.05,4.05)
Associate's degree after 26	-0.04	(-1.21,1.12)	-0.63	(-1.70,0.44)	-0.38	(-1.35,0.59)	0.2	(-1.72,2.11)
Baccalaureate degree by 26	0.57**	(0.17,0.98)	0.48	(-0.35,1.31)	0.83***	(0.37,1.28)	0.72	(-0.62,2.06)
Baccalaureate degree after 26	-0.7	(-1.42,0.01)	-0.84	(-1.94,0.27)	-0.73	(-1.54,0.07)	-1.67	(-3.50,0.17)
HS by 22 * age	0.01	(-0.00,0.03)	0.01	(-0.02,0.05)	0	(-0.02,0.02)	-0.01	(-0.06,0.04)
HS after 22 * age	0	(-0.02,0.02)	0.02	(-0.00,0.04)	0	(-0.02,0.03)	0.02	(-0.03,0.06)
Associate's degree by 26 * age	-0.01	(-0.04,0.02)	-0.03	(-0.07,0.01)	-0.02	(-0.05,0.01)	-0.07	(-0.16,0.01)
Associate's degree after 26 * age	0	(-0.03,0.03)	0.02	(-0.01,0.05)	0.01	(-0.02,0.03)	-0.01	(-0.07,0.05)
Baccalaureate degree by 26 * age	-0.04***	(-0.05,-0.02)	-0.02	(-0.05,0.01)	-0.05***	(-0.06,-0.03)	-0.03	(-0.08,0.02)
Baccalaureate degree after 26 * age	0.01	(-0.01,0.03)	0.02	(-0.01,0.06)	0.01	(-0.01,0.04)	0.05	(-0.01,0.11)
Age (years)	0.54***	(0.51,0.57)			0.52***	(0.48,0.56)		
Age squared	-0.00***	(-0.01,-0.00)			-0.00***	(-0.01,-0.00)		
Family income (log $)					-0.04	(-0.11,0.02)	-0.06	(-0.15,0.03)
Never married					-0.33***	(-0.42,-0.23)	-0.30***	(-0.39,-0.21)
Previously married					-0.43***	(-0.53,-0.33)	-0.41***	(-0.51,-0.31)
Unemployed					-0.01	(-0.10,0.08)	-0.01	(-0.09,0.07)
Out of labour force					0.07	(-0.04,0.18)	0.05	(-0.04,0.14)

* p<0.05, ** p<0.01, *** p<0.001

Appendix 5.3 Strata cutoffs

Women				Men			
Strata lower bound	No degree	Degree	Total	Strata lower bound	No degree	Degree	Total
0	1,409	60	1,469	0	1,515	62	1,577
0.1	399	61	460	0.1	413	63	476
0.2	258	67	325	0.2	247	69	316
0.3	186	82	268	0.3	168	71	239
0.4	193	223	416	0.4	198	199	397
0.6	98	257	355	0.6	78	246	324
Total	2,543	750	3,293	Total	2,619	710	3,329

References

Adelman, C. (2005). *Moving into Town--and Moving On: The Community College in the Lives of Traditional-Age Students*. Washington D.C.: US Department of Education. Retrieved from http://eric.ed.gov/?id=ED496111

Bastedo, M. N., & Jaquette, O. (2011). Running in Place: Low-Income Students and the Dynamics of Higher Education Stratification. *Educational Evaluation and Policy Analysis*, *33*(3), 318–339. http://doi.org/10.3102/0162373711406718

Bauldry, S. (2014). Conditional health-related benefits of higher education: An assessment of compensatory versus accumulative mechanisms. *Social Science & Medicine*, *111*, 94–100. http://doi.org/10.1016/j.socscimed.2014.04.005

Baum, C. L., & Ford, W. F. (2004). The wage effects of obesity: a longitudinal study. *Health Economics*, *13*(9), 885–899. http://doi.org/10.1002/hec.881

Becker, G. S., & Mulligan, C. B. (1997). The Endogenous Determination of Time Preference. *The Quarterly Journal of Economics*, *112*(3), 729–758. http://doi.org/10.1162/003355397555334

Ben-Shlomo, Y., & Kuh, D. (2002). A life course approach to chronic disease epidemiology: conceptual models, empirical challenges and interdisciplinary perspectives. *International Journal of Epidemiology*, *31*(2), 285–293. http://doi.org/10.1093/ije/31.2.285

Brand, J. E., & Davis, D. (2011). The Impact of College Education on Fertility: Evidence for Heterogeneous Effects. *Demography*, *48*(3), 863–887. http://doi.org/10.1007/s13524-011-0034-3

Brand, J. E., & Xie, Y. (2010). Who Benefits Most from College? Evidence for Negative Selection in Heterogeneous Economic Returns to Higher Education.

American Sociological Review, *75*(2), 273–302. http://doi.org/10.1177/0003122410363567

Brüder, J., & Ludwig, V. (2014). Fixed effects panel regression. In H. Best & C. Wolf (Eds.), *The SAGE Handbook of Regression Analysis and Causal Inference* (pp. 331–361). London: SAGE Publications Ltd.

Bruce, A. S., Black, W. R., Bruce, J. M., Daldalian, M., Martin, L. E., & Davis, A. M. (2011). Ability to Delay Gratification and BMI in Preadolescence. *Obesity*, *19*(5), 1101–1102. http://doi.org/10.1038/oby.2010.297

Cameron, S. V., & Heckman, J. J. (1991). *The Nonequivalence of High School Equivalents* (Working Paper No. 3804). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w3804

Campos, P., Saguy, A., Ernsberger, P., Oliver, E., & Gaesser, G. (2006). The epidemiology of overweight and obesity: public health crisis or moral panic? *International Journal of Epidemiology*, *35*(1), 55–60. http://doi.org/10.1093/ije/dyi254

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical Fitness and Academic Achievement in Third- and Fifth-Grade Students. *Journal of Sport and Exercise Psychology*, *29*(2), 239–252.

Chandola, T., Plewis, I., Morris, J. M., Mishra, G., & Blane, D. (2011). Is adult education associated with reduced coronary heart disease risk? *International Journal of Epidemiology*, *40*(6), 1499–1509. http://doi.org/10.1093/ije/dyr087

Creighton, S., & Hudson, L. (2002). *Participation Trends and Patterns in Adult Education: 1991-1999. Statistical Analysis Report.* Washington D.C.: National Center for Education Statistics, US Department of Education. Retrieved from http://eric.ed.gov/?id=ED463449

Crosnoe, R. (2007). Gender, Obesity, and Education. *Sociology of Education*, *80*(3), 241–260. http://doi.org/10.1177/003804070708000303

CSDH. (2008). Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health : Final Report of the Commission on Social Determinants of Health. World Health Organization.

Davison, K. K., & Birch, L. L. (2001). Weight Status, Parent Reaction, and Self-Concept in Five-Year-Old Girls. *Pediatrics*, *107*(1), 46–53. http://doi.org/10.1542/peds.107.1.46

Dietz, W. H. (1994). Critical periods in childhood for the development of obesity. *The American Journal of Clinical Nutrition*, *59*(5), 955–959.

Doeringer, P. B. (1990). Economic security, labor market flexibility, and bridges to retirement. In P. B. Doeringer (Ed.), *Bridges to Retirement: Older Workers in a Changing Labor Market* (pp. 3–19). Ithaca, NY: Cornell University Press.

Drewnowski, A. (2010). The Cost of US Foods as Related to Their Nutritive Value. *The American Journal of Clinical Nutrition*, *92*(5), 1181–1188. http://doi.org/10.3945/ajcn.2010.29300

Drewnowski, A., & Darmon, N. (2005). Food Choices and Diet Costs: an Economic Analysis. *The Journal of Nutrition*, *135*(4), 900–904.

Duncan, G. J., Daly, M. C., McDonough, P., & Williams, D. R. (2002). Optimal Indicators of Socioeconomic Status for Health Research. *American Journal of Public Health*, *92*(7), 1151–1157. http://doi.org/10.2105/AJPH.92.7.1151

Edwards, R. D. (2010). *Health, Income, and the Timing of Education Among Military Retirees* (Working Paper No. 15778). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w15778

Elman, C., & O'Rand, A. M. (2004). The Race Is to the Swift: Socioeconomic Origins, Adult Education, and Wage Attainment. *American Journal of Sociology*, *110*(1), 123–160. http://doi.org/10.1086/386273

Elman, C., & O'Rand, A. M. (2007). The effects of social origins, life events, and institutional sorting on adults' school transitions. *Social Science Research*, *36*(3), 1276–1299. http://doi.org/10.1016/j.ssresearch.2006.11.001

Elman, C., & Weiss, F. (2014). Adult educational participation and implications for employment in the US context. In H.-P. Blossfeld, E. Kilpi-Jakonen, D. Vono de Vilhena, & S. Buchholz (Eds.), *Adult Learning in Modern Societies: An International Comparison from a Life-course Perspective*. Edward Elgar Publishing.

Falkner, N. H., French, S. A., Jeffery, R. W., Neumark-Sztainer, D., Sherwood, N. E., & Morton, N. (1999). Mistreatment Due to Weight: Prevalence and Sources of Perceived Mistreatment in Women and Men. *Obesity Research*, *7*(6), 572–576. http://doi.org/10.1002/j.1550-8528.1999.tb00716.x

Falkner, N. H., Neumark-Sztainer, D., Story, M., Jeffery, R. W., Beuhring, T., & Resnick, M. D. (2001). Social, Educational, and Psychological Correlates of Weight Status in Adolescents. *Obesity Research*, *9*(1), 32–42. http://doi.org/10.1038/oby.2001.5

Ferraro, K. F., & Kelley-Moore, J. A. (2003). Cumulative Disadvantage and Health: Long-Term Consequences of Obesity? *American Sociological Review*, *68*(5), 707–729. http://doi.org/10.2307/1519759

Ferraro, K. F., & Shippee, T. P. (2009). Aging and Cumulative Inequality: How Does Inequality Get Under the Skin? *The Gerontologist*, *49*(3), 333–343. http://doi.org/10.1093/geront/gnp034

Fowler-Brown, A. G., Ngo, L. H., Phillips, R. S., & Wee, C. C. (2010). Adolescent Obesity and Future College Degree Attainment. *Obesity*, *18*(6), 1235–1241. http://doi.org/10.1038/oby.2009.463

Galobardes, B., Shaw, M., Lawlor, D. A., Lynch, J. W., & Smith, G. D. (2006). Indicators of socioeconomic position (part 1). *Journal of Epidemiology and Community Health*, *60*(1), 7–12. http://doi.org/10.1136/jech.2004.023531

Gilardi, S., & Guglielmetti, C. (2011). University Life of Non-Traditional Students: Engagement Styles and Impact on Attrition. *The Journal of Higher Education*, *82*(1), 33–53.

Gortmaker, S. L., Must, A., Perrin, J. M., Sobol, A. M., & Dietz, W. H. (1993). Social and Economic Consequences of Overweight in Adolescence and Young Adulthood. *New England Journal of Medicine*, *329*(14), 1008–1012. http://doi.org/10.1056/NEJM199309303291406

Hallqvist, J., Lynch, J., Bartley, M., Lang, T., & Blane, D. (2004). Can we disentangle life course processes of accumulation, critical period and social mobility? An analysis of disadvantaged socio-economic positions and myocardial infarction in the Stockholm Heart Epidemiology Program. *Social Science & Medicine*, *58*(8), 1555–1562. http://doi.org/10.1016/S0277-9536(03)00344-7

Han, E., Norton, E. C., & Stearns, S. C. (2009). Weight and wages: fat versus lean paychecks. *Health Economics*, *18*(5), 535–548. http://doi.org/10.1002/hec.1386

Harper, S., & Strumpf, E. C. (2012). Social Epidemiology: Questionable Answers and Answerable Questions. *Epidemiology*, *23*(6), 795–798. http://doi.org/10.1097/EDE.0b013e31826d078d

Hillman, C. H., Motl, R. W., Pontifex, M. B., Posthuma, D., Stubbe, J. H., Boomsma, D. I., & de Geus, E. J. C. (2006). Physical activity and cognitive function in a cross-section of younger and older community-dwelling individuals. *Health Psychology*, *25*(6), 678–687. http://doi.org/10.1037/0278-6133.25.6.678

Hubert, H. B., Feinleib, M., McNamara, P. M., & Castelli, W. P. (1983). Obesity as an independent risk factor for cardiovascular disease: a 26-year follow-up of participants in the Framingham Heart Study. *Circulation*, *67*(5), 968–977. http://doi.org/10.1161/01.CIR.67.5.968

Huurre, T., Aro, H., & Rahkonen, O. (2003). Well-being and health behaviour by parental socioeconomic status. *Social Psychiatry and Psychiatric Epidemiology*, *38*(5), 249–255. http://doi.org/10.1007/s00127-003-0630-7

Jokela, M., Hintsanen, M., Hakulinen, C., Batty, G. D., Nabi, H., Singh-Manoux, A., & Kivimäki, M. (2013). Association of personality with the development and persistence of obesity: a meta-analysis based on individual–participant data. *Obesity Reviews*, *14*(4), 315–323. http://doi.org/10.1111/obr.12007Karabel, J., & Astin, A. W. (1975). Social Class, Academic Ability, and College "Quality." *Social Forces*, *53*(3), 381–398. http://doi.org/10.1093/sf/53.3.381

Karnehed, N., Rasmussen, F., Hemmingsson, T., & Tynelius, P. (2006). Obesity and Attained Education: Cohort Study of More Than 700,000 Swedish Men. *Obesity*, *14*(8), 1421–1428. http://doi.org/10.1038/oby.2006.161

Kenkel, D. S., Lillard, D. R., & Mathios, A. D. (2006). *The Roles of High School Completion and GED Receipt in Smoking and Obesity* (Working Paper No. 11990). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w11990

Kim, S., & Popkin, B. M. (2006). Commentary: Understanding the epidemiology of overweight and obesity—a real global public health concern. *International Journal of Epidemiology*, *35*(1), 60–67. http://doi.org/10.1093/ije/dyi255

Kodde, D. A., & Ritzen, J. M. M. (1988). Direct and Indirect Effects of Parental Education Level on the Demand for Higher Education. *The Journal of Human Resources*, *23*(3), 356–371. http://doi.org/10.2307/145834

Kovalchik, S. (2009). Validity of adult lifetime self-reported body weight. *Public Health Nutrition*, *12*(08), 1072–1077. http://doi.org/10.1017/S1368980008003728

Kramer, A. F., & Erickson, K. I. (2007). Capitalizing on cortical plasticity: influence of physical activity on cognition and brain function. *Trends in Cognitive Sciences*, *11*(8), 342–348. http://doi.org/10.1016/j.tics.2007.06.009

Liu, S. Y., Buka, S. L., Kubzansky, L. D., Kawachi, I., Gilman, S. E., & Loucks, E. B. (2013). Sheepskin effects of education in the 10-year Framingham risk of coronary heart disease. *Social Science & Medicine*, *80*, 31–36. http://doi.org/10.1016/j.socscimed.2012.12.026

Liu, S. Y., Buka, S. L., Linkletter, C. D., Kawachi, I., Kubzansky, L., & Loucks, E. B. (2011). The Association Between Blood Pressure and Years of Schooling Versus Educational Credentials: Test of the Sheepskin Effect. *Annals of Epidemiology*, *21*(2), 128–138. http://doi.org/10.1016/j.annepidem.2010.11.004

Liu, S. Y., Chavan, N. R., & Glymour, M. M. (2013). Type of High-School Credentials and Older Age ADL and IADL Limitations: Is the GED Credential Equivalent to a Diploma? *The Gerontologist*, *53*(2), 326–333. http://doi.org/10.1093/geront/gns077

Low, B. J., & Low, M. D. (2006). Education and Education Policy as Social Determinants of Health. *Virtual Mentor*, *8*(11), 756–761. http://doi.org/10.1001/virtualmentor.2006.8.11.pfor1-0611

Low, M., Low, B., Baumler, E., & Huynh, P. (2005). Can education policy be health policy? Implications of research on the social determinants of health. *Journal of Health Politics, Policy & Law*, *30*(6), 1131–1162.

Masters, R. K., Hummer, R. A., & Powers, D. A. (2012). Educational Differences in U.S. Adult Mortality A Cohort Perspective. *American Sociological Review*, *77*(4), 548–572. http://doi.org/10.1177/0003122412451019

Mirowsky, J., & Ross, C. E. (2003). *Education, Social Status, and Health*. Hawthorne, NY: Aldine de Gruyter.

Mitra, A. (2001). Effects of physical attributes on the wages of males and females. *Applied Economics Letters*, *8*(11), 731–735. http://doi.org/10.1080/13504850110047605

Montez, J. K., Hummer, R. A., & Hayward, M. D. (2012). Educational Attainment and Adult Mortality in the United States: A Systematic Analysis of Functional Form. *Demography*, *49*(1), 315–336. http://doi.org/10.1007/s13524-011-0082-8

National Center for Education Statistics, US Department of Education. (2014). *Characteristics of Postsecondary Students*.

Neumark-Sztainer, D., Story, M., & Harris, T. (1999). Beliefs and Attitudes about Obesity among Teachers and School Health Care Providers Working with Adolescents. *Journal of Nutrition Education*, *31*(1), 3–9. http://doi.org/10.1016/S0022-3182(99)70378-X

O'Donnell, K. (2006). *Adult education participation in 2004-05 (NCES 2006-077).* Washington, D.C.: National Center for Education Statistics, US Department of Education. Retrieved from http://www.voced.edu.au/content/ngv40658

Orbach, S. (2006). Commentary: There is a public health crisis—its not fat on the body but fat in the mind and the fat of profits. *International Journal of Epidemiology*, *35*(1), 67–69. http://doi.org/10.1093/ije/dyi256

Oseguera, L., & Astin, A. W. (2004). The Declining "Equity" of American Higher Education. *The Review of Higher Education*, *27*(3), 321–341. http://doi.org/10.1353/rhe.2004.0001

Østbye, T., Malhotra, R., & Landerman, L. R. (2011). Body mass trajectories through adulthood: results from the National Longitudinal Survey of Youth 1979 Cohort (1981–2006). *International Journal of Epidemiology*, *40*(1), 240–250. http://doi.org/10.1093/ije/dyq142

Parsons, T. j., Powers, C., Logan, S., & Summerbell, C. d. (1999). Childhood predictors of adult obesity: a systematic review. *International Journal of Obesity & Related Metabolic Disorders*, *23*, S1–S107.

Perneger, T. V. (1998). What's Wrong with Bonferroni Adjustments. *BMJ: British Medical Journal*, *316*(7139), 1236–1238.

Power, C., Graham, H., Due, P., Hallqvist, J., Joung, I., Kuh, D., & Lynch, J. (2005). The contribution of childhood and adult socioeconomic position to adult obesity and smoking behaviour: an international comparison. *International Journal of Epidemiology*, *34*(2), 335–344. http://doi.org/10.1093/ije/dyh394

Power, C., Graham, H., Due, P., Hallqvist, J., Joung, I., Kuh, D., & Lynch, J. (2005). The contribution of childhood and adult socioeconomic position to adult obesity and smoking behaviour: an international comparison. *International Journal of Epidemiology*, *34*(2), 335–344. http://doi.org/10.1093/ije/dyh394

Provencher, V., Bégin, C., Gagnon-Girouard, M.-P., Tremblay, A., Boivin, S., & Lemieux, S. (2008). Personality traits in overweight and obese women:

Associations with BMI and eating behaviors. *Eating Behaviors*, *9*(3), 294–302. http://doi.org/10.1016/j.eatbeh.2007.10.004

Puhl, R. M., & Latner, J. D. (2007). Stigma, obesity, and the health of the nation's children. *Psychological Bulletin*, *133*(4), 557–580. http://doi.org/10.1037/0033-2909.133.4.557

Riley, J. C. (1989). Sickness, Recovery, and Death: A History and Forecast of Ill Health. University of Iowa Press.

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41–55. http://doi.org/10.1093/biomet/70.1.41

Ross, C. E., & Mirowsky, J. (2010). Gender and the Health Benefits of Education. *Sociological Quarterly*, *51*(1), 1–19. http://doi.org/10.1111/j.1533-8525.2009.01164.x

Ross, C. E., & Mirowsky, J. (2011). The interaction of personal and parental education on health. *Social Science & Medicine*, *72*(4), 591–599. http://doi.org/10.1016/j.socscimed.2010.11.028

Rubin, D. B. (1987). Multiple Imputation for Nonresponse in Surveys. Wiley:New York, New York.

Schafer, M. H., Wilkinson, L. R., & Ferraro, K. F. (2013). Childhood (Mis)fortune, Educational Attainment, and Adult Health: Contingent Benefits of a College Degree? *Social Forces*, *91*(3), 1007–1034. http://doi.org/10.1093/sf/sos192

Taniguchi, H. (2005). The Influence of Age at Degree Completion on College Wage Premiums. *Research in Higher Education*, *46*(8), 861–881. http://doi.org/10.1007/s11162-005-6932-8

Taniguchi, H., & Kaufman, G. (2007). Belated entry: Gender differences and similarities in the pattern of nontraditional college enrollment. *Social Science Research*, *36*(2), 550–568. http://doi.org/10.1016/j.ssresearch.2006.03.003

Tsai, A. G., Williamson, D. F., & Glick, H. A. (2011). Direct medical cost of overweight and obesity in the USA: a quantitative systematic review. *Obesity Reviews*, *12*(1), 50–61. http://doi.org/10.1111/j.1467-789X.2009.00708.x

U.S. Department of Education, National Center for Education Statistics. (2012). *The Condition of Education 2012 (NCES 2012-45) Indicator 47*. U.S. Department of Education, National Center for Education Statistics.

von Hippel, P. T., & Lynch, J. L. (2014). Why are educated adults slim—Causation or selection? *Social Science & Medicine*, *105*, 131–139. http://doi.org/10.1016/j.socscimed.2014.01.004

Walpole, M. (2003). Socioeconomic Status and College: How SES Affects College Experiences and Outcomes. *The Review of Higher Education*, *27*(1), 45–73. http://doi.org/10.1353/rhe.2003.0044

Walsemann, K. M., Geronimus, A. T., & Gee, G. C. (2008). Accumulating Disadvantage Over the Life Course Evidence From a Longitudinal Study Investigating the Relationship Between Educational Advantage in Youth and Health in Middle Age. *Research on Aging*, *30*(2), 169–199. http://doi.org/10.1177/0164027507311149

Walsemann, K. M., Bell, B. A., & Hummer, R. A. (2012). Effects of Timing and Level of Degree Attained on Depressive Symptoms and Self-Rated Health at Midlife. *American Journal of Public Health*, *102*(3), 557–563. http://doi.org/10.2105/AJPH.2011.300216

Wardle, J., & Steptoe, A. (2003). Socioeconomic differences in attitudes and beliefs about healthy lifestyles. *Journal of Epidemiology and Community Health*, *57*(6), 440–443. http://doi.org/10.1136/jech.57.6.440

Weller, R. E., Cook III, E. W., Avsar, K. B., & Cox, J. E. (2008). Obese women show greater delay discounting than healthy-weight women. *Appetite*, *51*(3), 563–569. http://doi.org/10.1016/j.appet.2008.04.010

Woo, J., Green, C., & Matthews, M. (2013). *Profile of 2007-08 First-Time Bachelor's Degree Recipients in 2009*. Washington D.C.: National Center for Education Statistics, US Department of Education.

Xie, Y. (2011). Causal inferenece and heterogeneity bias in social science. *Information, Knowledge, Systems Management*, *10*(1), 279–289. http://doi.org/10.3233/IKS-2012-0197

Xie, Y., Brand, J. E., & Jann, B. (2012). Estimating Heterogeneous Treatment Effects with Observational Data. *Sociological Methodology*, *42*(1), 314–347. http://doi.org/10.1177/0081175012452652